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THE ELECTRICAL REVIEW

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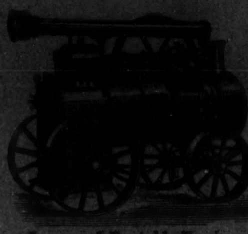

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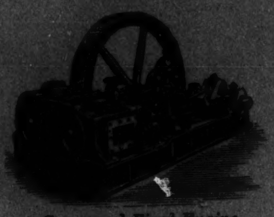

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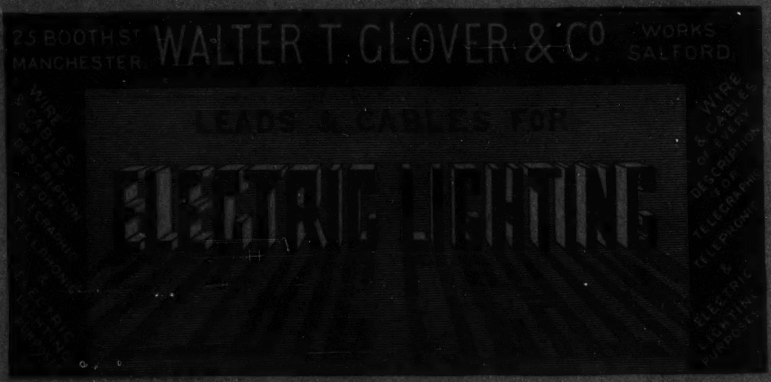
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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVI.—NO. 372.

ELECTRIC CABLES.

THE attempts which are made to devise a practical and cheap system of underground telegraphs continue to be numerous, but the actual progress which is made is not very marked. A history of underground telegraphs would indeed be a long list of failures, commencing in 1837 with the so-called "fossil" telegraph of Wheatstone, which consisted of bare wires placed in grooves in lengths of oak scantling. Most of these failures have not been due so much to actual defects in the inventions as to the inability of the inventors to push their commodities, owing to force of circumstances. The use of gutta percha shows no signs of falling off, and no substance has yet been brought into the market which has been proved to be a substitute for it. Great attention is now being paid to lead covered cables, the insulation of the latter, as in the Berthoud-Borel system, being due to resinous substances, which are far cheaper than gutta percha. Provided the lead covering remains intact, there is no reason whatever why such cables should not remain good for an indefinite period. In certain soils lead is practically imperishable; but, again, where clay is present, rapid decay occurs. About 10 years ago a cable consisting of a cotton covered wire placed in a lead pipe, the latter being filled with paraffin wax, was laid in Windsor Park in a clay soil; in a very short time this line became defective, and on examination it was found that the lead covering had been eaten into holes, which, by admitting moisture, rendered the wire useless; in this case the paraffin wax was not able to effectually coat the copper core. Excellent as paraffin wax is as an insulator, it has the great defect that it shrinks very considerably on cooling, and is therefore extremely liable to crack; indeed, most substances of this nature possess this element of uncertainty, and when used as insulators they practically can only be relied upon as "separators" to prevent metallic contact between a number of wires, or between the latter and a metal sheathing, the sheathing being the medium which keeps moisture out. Lead, as a protecting covering, necessarily means considerable weight, and as a means of preserving single wires could hardly be adopted to any great extent. Multiple cables would have more chance of success, though the fact that the units of which they are built up are practically inseparable is a disadvantage; and, moreover, if moisture does penetrate, it means that nearly all, if not all, the wires will become defective. For very special purposes, however, the lead covered cables should prove to be all that can be desired. The use of paraffin oil as an insulator in the Brooks system has yielded excellent results, and is an undoubted success, but we are inclined to think that more satisfactory results might be obtained from a semi-fluid material, *i.e.*, one which would not be liable to become dispersed by leakage, but which would at the same time have the property of settling down if by any chance it were disturbed, and thus sealing up accidental faults. There seems at present but little chance of India rubber or gutta percha being superseded for submarine purposes, but the employment of a cheap yet efficient substitute for either of these materials would probably give a renewed impulse to such telegraphy, and would richly reward the inventor.

THE ECONOMY OF THE ELECTRIC LIGHT.[*]

A paper read before the Mechanical Section of the American Association for the Advancement of Science, by ALLAN STIRLING.

AS the title of this paper indicates, it is not my intention to speak of all the advantages that accrue from the introduction of the electric light, but to call attention to some considerations which are likely to accelerate its general adoption on the score of economy. That the electric light has many advantages over gas light is admitted, and if it can be shown to be more economical its use will become universal.

The primary source of the light in both cases is the same, viz., the combustion of carbon, but a marked difference is found in the fact that in the case of gas lighting the carbon is carried to the point where the light is produced, and there burned; but with the electric light the carbon is burned in the furnace of a steam boiler, and the heat converted into power, this power being used to generate electricity, which in its passage through a filament fixed at the point where the light is wanted, renders the filament incandescent, producing the light.

Keeping this difference in mind, let us see what is the relative cost of the two systems. We will take for illustration 10 blocks of houses, and assume that each block requires 1,200 17 candle-power lights. For the purpose of this paper we will divide the year into two equal parts, viz., warm and cold, or summer and winter. This division is made because, as will be seen later, the fact of our severe winter has an important influence on the subject we are considering. We will assume that in summer one-third of the burners are used for three hours every evening, and that in winter two-thirds of the burners are used for four hours every evening.

The present cost of gas to the consumer can be readily ascertained, as its manufacture and distribution are thoroughly developed, and the companies charge a fixed price per 1,000 feet delivered through the meter of the consumer. A good burner, using 5 feet of gas per hour will give a 17 candle light. The cost of gas to the consumer is $2.25 per 1,000 feet, a price which is taken from my last gas bill in New York.

Cost for summer:—4,000 lights for $182\frac{1}{2}$ days of 3 hours each, at 5 feet per hour = 10,950,000 feet, which, at $2.25 per 1,000, $24,637,50. Cost for winter:—8,000 lights for $182\frac{1}{2}$ days of 4 hours each, at 5 feet per hour = 29,200,000 feet, which, at $2.25 per 1,000, $65,700. Total for year, $90,337.50.

This will represent the total cost to the consumer of the gas illumination, including interest, depreciation, repairs, attendance, &c., all expenses being included in the price of gas.

The cost of the electric illumination will not be so easily determined, because this system is not so fully developed as the other. We will, therefore, take the items of the cost separately, and estimate each item from the experience gained up to the present time, and then indicate some possible reductions that may be made in this cost by improved methods.

---

[*] *The American Engineer.*

The items that go to make up the cost of electric lighting are as follows :—1. Coal for boilers ; 2. Water for boilers ; 3. Lamp renewals ; 4. Miscellaneous supplies ; 5. Wages of attendants ; 6. Repairs and depreciation ; 7. Interest account.

1. *Coal for Boilers.*—With a good electric plant, one horse-power will furnish eight lights of 17 candle-power each. For our imaginary plant, 500 horse-power would be required for three hours each day in summer and 1,000 horse-power for four hours each day in winter. Assume three pounds of coal per horse-power (a fair allowance for good non-condensing engines) and that the cost of coal is $5 per ton of 2,240 lbs., delivered. Cost for summer : 500 horse-power for $182\frac{1}{2}$ days of 3 hours each, at 3 lbs. coal per horse-power per hour = 821,250 lbs. coal, or 366 tons (of 2,240 lbs) ; which, at $5 per ton, $1,830. Cost for winter : 1,000 horse-power for $182\frac{1}{2}$ days of 4 hours each, at 3 lbs. coal per horse-power per hour = 2,190,000 lbs. coal, or 980 tons (of 2,240 lbs.) ; which, at $5 per ton, $4,900. Total cost for coal, $6,750.

2. *Water for the Boilers.*—A fair allowance of water is 27 lbs. per horse-power per hour. The price in New York is $13\frac{1}{2}$ cents per thousand gallons. Water for summer : 273,753 horse-power hours, at 27 lbs. per horse-power = approximately, 923,900 gallons ; which, at $13\frac{1}{2}$ cents per thousand, $124.50. Water for winter : 730,000 horse-power hours, at 27 lbs. per horse-power = approximately, 2,463,750 gallons ; which, at $13\frac{1}{2}$ cents per thousand, $332.50. Total cost of water, $457.

3. *Lamp Renewals.*—It is safe to estimate the life of the carbon filaments at 600 hours, and that the cost of each renewal will be 90 cents. Summer : 4,000 lamps for $182\frac{1}{2}$ days of 3 hours each = 2,190,000 lamp hours. Winter : 8,000 lamps for $182\frac{1}{2}$ days of 4 hours each = 5,840,000 lamp hours. Total, 8,030,000 lamp hours, which, divided by 600, gives 13,383 lamp renewals, at 90 cents each, $12,044.70.

4. *The Miscellaneous Supplies* will cost about $300 for the summer and $450 for the winter = $750 a year.

5. *Wages of Attendants.*—As the plant is in operation less than half of a working day, the repairs to wires, lamps, &c., can be made by the engineer, and the coal can be trimmed by the fireman when the plant is not in operation. This being the case, one engineer and one fireman will be all that is necessary in summer, and one additional fireman will be required in winter. Allowing $4 per day for engineer and $2.50 per day for fireman, we have : For summer, $182\frac{1}{2}$ days, at $6.50 = $1,186 ; for winter, $182\frac{1}{2}$ days, at $9 = $1,642.50. Total cost of attendants, $2,828.50.

6 and 7.—In order to arrive at the proper charge for depreciation and interest, let us estimate the cost of the plant : Cost of ground and building, $15,000 ; engines and boilers, $50,000 ; dynamos, $40,000. Total, $105,000. Wiring and fixtures would not cost any more than gas pipes and the usual gas fixtures. Allowing 10 per cent. on the above amount for repairs and depreciation, the charge to that account will be $10,500. A similar charge should be made for interest.

RECAPITULATION.

1. Cost for boilers	$6,750.00
2. Water for boilers	457.00
3. Lamp renewals	12,044.70
4. Miscellaneous supplies	750.00
5. Wages of attendants	2,828.50
6. Repairs and depreciation of plant ...	10,500.00
7. Interest account	10,500.00
	$43,830.20

Cost of gas illumination	$90,337.50
Cost of electric illumination	43,830.20
Difference in favour of electricity ...	$46,507.30

Showing that the same amount of light can be furnished by electricity for less than 50 per cent. of the present price of gas, or equivalent to gas at $1.12 per 1,000 feet, and at the same time earn 10 per cent. on the investment. Dividing this profit equally between the producer and consumer, the electric light would be equal in price to gas at $1.69 per 1,000, and the electric light company would earn a still further dividend of 20 per cent., making a total of 30 per cent. per annum, which could be paid to the shareholders of the electric light company after paying all expenses and making ample allowance for repairs and depreciation.

Now let us consider what further economy may be made in electric lighting. I have already stated that the fact of our severe winter has an important influence, and it is this influence which I now propose to consider. Engineers who have studied steam know that with our engines only a small fraction of the theoretical economy is realised by the best of them. 1 lb. of ordinary coal develops 12,000 units of heat, which represent 12,000 × 772 (Joule's equivalent) = 9,264,000 foot pounds or units of force, which is less than $\frac{1}{4}$ lb. of coal per horse-power per hour, and, as we have allowed 3 lbs. of coal per horse-power per hour, it is evident that the engine only gives back in work one-twelfth of the heat furnished to it, the other eleven-twelfths being rejected and sent out of the exhaust pipe. The combination of the electric light with the heating apparatus in our cold winters furnishes the basis for a perfect utilisation of all the heat in the coal. Instead of burning the coal for heating in separate hot air or other warming apparatus in each house let us burn it at our electric light station, dispensing at the same time with the dirt and trouble connected with having a furnace in each house. We will convert the heat of the coal into high pressure steam. First, passing this steam through an economical steam engine, converting all we can of it into mechanical work, using this part for lighting the buildings, and instead of wasting the greater part of it by sending it out through the exhaust pipe, all the heat rejected by the engines will be employed usefully by sending it into the heating apparatus of the buildings, where it will be condensed and returned to the boilers as water to be re-evaporated. In this way the same coal (with a very slight addition, if any,) will both light and warm the buildings. The effect of this will be that during the winter only about one-twelfth of the coal burned, the water used, the wages of firemen and of the repairs, depreciation and interest on boilers will be chargeable to the lighting. Revising our estimates accordingly, the account will stand as follows :—

Coal for boilers	$2,350.00
Water for boilers	154.00
Lamp renewals	12,044.70
Miscellaneous supplies	750.00
Wages of attendants	2,007.00
Repairs and depreciation of plant ...	9,000.00
Interest account	9,000.00
	$35,305.70

Deducting this from our original estimate, we have a saving of $8,525, which, divided equally between the consumer and the light company, brings the illumination down to the basis of $1.48 per thousand feet of gas, and divides a further 7 per cent. among the shareholders of the company.

The following calculation will confirm, in a different way, the correctness of the above estimate of the amount of coal required to furnish the mechanical work necessary to run the lighting plant during the winter. The units of work required for the six months will be as follows : 1,000 horse-power for $182\frac{1}{2}$ days of 4 hours each = 730,000 horse-power hours, which (60 minutes per hour and 33,000 foot pounds per horse-power) are equivalent to 1,445,400,000,000 total units of work.

Each pound of coal, as before stated, represents 9,264,000 units of work, foot pounds, or units of force ; so the above is equivalent to 156,000 pounds, or 70 tons of coal of 2,240 pounds ; allowing for friction and other losses, say 100 tons of coal. This 100 tons of coal is all the additional coal needed for the electric illumination over and above that which will be required in any case for the heating of the houses in winter. The receiver type of compound engine (suppressing the low-pressure cylinder) shows that it is possible to get power at the bare cost of its mechanical equivalent of heat, by utilising the steam for heating purposes, at the approximate constant pressure of the receiver. If the whole of the steam rejected from the first cylinder could be used for heating purposes, precisely as if the same volume had been supplied from an independent boiler at that pressure, the engine would be a single cylinder non-condensing, with a back pressure in its receiver sufficiently high for effecting the required utilisation, the second cylinder being suppressed. In this case the whole work done would be obtained practically at cost of the mechanical equivalent of heat.

The coal consumption in summer can be still further reduced by using high-pressure steam, the probable saving in this way being about one-third of the coal and water in our estimates. Making this correction, we have $657 to divide, bringing the cost of equal gas down to $1.46½ per thousand and paying another ⅔rd of 1 per cent. to the company.

By referring to the items of the cost of electric lighting, it will be seen that the largest item is for lamp renewals. A further great reduction in cost is possible here, say by extending the average life of the carbon filaments to 1,200 hours and by reducing the cost of renewals to 45 cents. This would make a reduction of $9,039 per annum, reducing the price of gas to $1.25 per thousand and paying an additional 10 per cent. to the shareholders.

The introduction of the electric light, if conducted under the guidance of educated and experienced mechanical engineers, and if properly done, will yield immediate and ample returns. As at present developed, it can compete with gas at $1.69 per thousand feet and pay the shareholders 30 per cent. per annum on their investment. If the improvements indicated above are introduced, it can compete with gas at $1.25 per thousand feet and at the same time pay 47⅔ per cent. to the electric light shareholders.

THE SECONDARY GENERATORS OF GAULARD AND GIBBS.

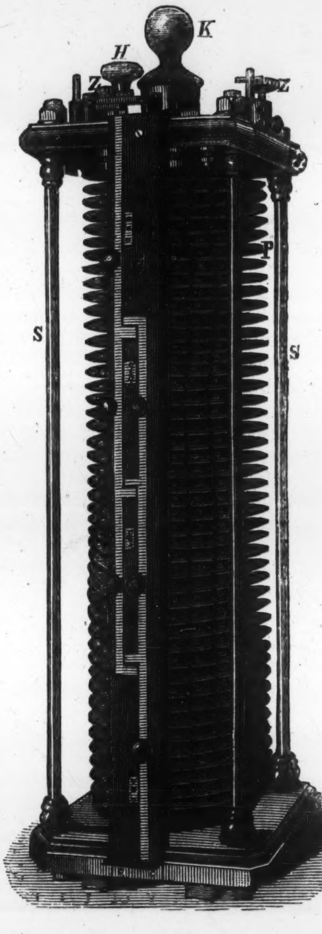
IN electro-technical circles it is in serious contemplation to effect the distribution of electrical energy from central stations not by means of accumulators but by secondary generators. The apparatus so-called, in the stricter acceptation, are, in their present form, induction bobbins with flat spirals pressed into each other.

The primary spiral consists of flat annular plates of sheet copper. ¼-millimetre in thickness and 3½-centimetres in width. At the point where they have to join up to each other, there is an eye in a kind of projecting tooth. This serves to connect the first annular ring to the second, which is again connected in the same manner to the third, and thus the primary spiral is composed of a series of such plates.

Between each two annular plates, which are left bright, there intervenes a plate of the same metal and the same size, belonging to the secondary spiral, covered with a black insulating mass. Between the black and the bright copper plates there are further introduced rings of parchment as insulators. Thus a column, constituting a secondary generator, is formed of a great number of such flat rings. The first, third, fifth, &c., form the primary, whilst the second, fourth, sixth, form the secondary bobbin. There passes through the former the inducing current, of very high tension (2,500 to 3,000 volts have been mentioned).

The secondary column can be put together at pleasure, the flat rings being arranged either in succession or side by side, as convenience requires. The accompanying figure shows the form of the generators as exhibited at Turin.

Between the supports, S, S, fixed on a wooden foot, the primary and secondary plates, P, are arranged as a column. The eyes which serve to connect each two consecutive rings are visible in the figure. Z and Z are the clamps for introducing the primary current; H is the handle for connecting or disconnecting the induction coil. The metal core, K, serves for increasing or diminishing the induction, according as it is pushed more or less deeply into the induction bobbin. The inventors are attempting to produce this effect by an automatic arrangement, and thus obtain a spontaneous regulation of the currents. The plates visible on the front bar, C, contain the connections for the secondary currents, which may be derived at pleasure for arc or for glow lights, or for both simultaneously.



The deviation for these different purposes is very convenient in this apparatus. The useful return of the secondary generators, though not yet precisely determined, will be considerably higher than in any previous apparatus of this kind, on account of the ingenious utilisation of the inductive action of the primary upon the secondary bobbins, and probably higher than in accumulators.

Still this apparatus has its weak side, which we must at once point out. The greater the resistance in the secondary circuit, *i.e.*, the more work there is thrown upon the secondary generators with a parallel arrangement of the lamps, the less is their performance. If we plot out the curve of work performed at different resistances (regarded as abscissæ) it would appear, on employing the existing means of regulation, as a line inclined towards the axis of the abscissæ. But the desired object, *i.e.*, to make the work perfectly proportional to the demand, is not attained.

In addition to this property of secondary generators, opponents of the invention have succeeded in pointing out other defects. The measurements undertaken by Dr. Hopkinson in London in the middle of March last have shown an electrical result of 86—89 per cent. In these measurements Dr. Hopkinson himself, though no opponent of the generators, perceived that if only a portion of the working apparatus is utilised the result of the active columns is deteriorated, since another portion of the work remains useless in the inactive columns. It must be remarked that in that result (89 per cent.) the 3,630 voltampères which are absorbed by the resistance in the circuit, are included as useful work. Certainly these voltampères are also added in to the value which expresses the total work.

Still, as Hospitalier points out, it is more useful than fair in valuing the effect, to add one and the same number both to the numerator and the denominator of the fraction expressive of the yield of the apparatus.

Besides Hospitalier, Bright, and Gordon rank among those who consider the apparatus of Gaulard and Gibbs as in part not new and in part not remunerative. The more recent form of the apparatus may, however, claim a different judgment.

It is well known that at Turin most satisfactory experiments have been made with secondary generators. The inventors claim, as the most prominent, the essential purpose of their construction, the possibility of the distribution of electric energy, and in this exhibition they have shown themselves so close upon the attainment of this object that a sum of 10,000 francs and a gold medal were awarded to them as an encouragement to persevere in the direction they have taken and as a reward for their achievement.

This prize was a portion of the sum of 15,000 francs which the Italian Government had offered for the best result in applied electricity.

The experiment itself was as follows:—In the Exhibition building stood a Siemens alternating current machine, which required to be actuated by 30-horse power; in the kiosk of the *Figaro*, in a court of the Exhibition space, was a small secondary generator supplying five Swan lamps; in the Turin railway station there were 34 Edison lamps at 16 normal candles, 48 at eight normal candles, and a Siemens arc light. At the station Veneria Reale there were two Siemens arc lights; at Lanzo, a small village in the Alps of Savoy, there were burning nine Bernstein lamps, 16 Swan lamps at 100 V., one Sun lamp and two Siemens arc lights. In the vicinity of the alternating machine, in the Exhibition building itself, nine Swan, nine Bernstein, and one Sun lamp were supplied by the secondary generators placed there. These various places were connected by a wire of chrome bronze of the conductivity of 98 °/ₒ (electrolytically pure copper = 100). This wire, which had been lent by the firm Mouchel, of Paris, was 3·7 millimetres in thickness, 80 kilometres in length (including the return conductor), and was supported on ordinary telegraph posts. The working was carried on undisturbed for five hours, and was considered worthy of the rewards above mentioned. The jury, including men like Tresca, Weber (Zürich), Ferrini, Ferraris, Wartmann, Voit, and Kittler, expressed themselves as follows: "Though the conversion of feeble currents into strong ones by means of induction is not novel, the jury admit that the most recent form given to the induction apparatus by Gaulard and Gibbs is the most rational, and effects the transformation with the smallest waste. It was resolved to award 10,000 francs to these gentlemen, to be applied to the further development of a system so suitable for distributing the electric light over extensive districts."

The measurements undertaken at Turin are said to have shown, with these generators, a useful effect of 90 per cent. In judging this percentage we must remember that it depends on the values introduced into the numerator and the denominator of the fraction, and that a complete and clear statement of the methods of measurement employed has not yet been furnished. These methods do not seem to afford an accuracy free from all objections. Professor Galileo Ferraris, during the Exhibition itself, which was prolonged far into October, was engaged with determining the useful effect of the generators calorimetrically.

The measurements undertaken by the jury refer to a generator arranged to furnish two electric horse-power (1,492 voltampères).

The primary current had the strength of 12 ampères, and traversed a resistance of 11·8 ohm. The apparatus consisted of 1,000 of the discs above described, of 12 centimetres exterior diameter; the diameter of the internal section was 5 centimetres, and the thickness of the plate was $\frac{1}{4}$ millimetre.

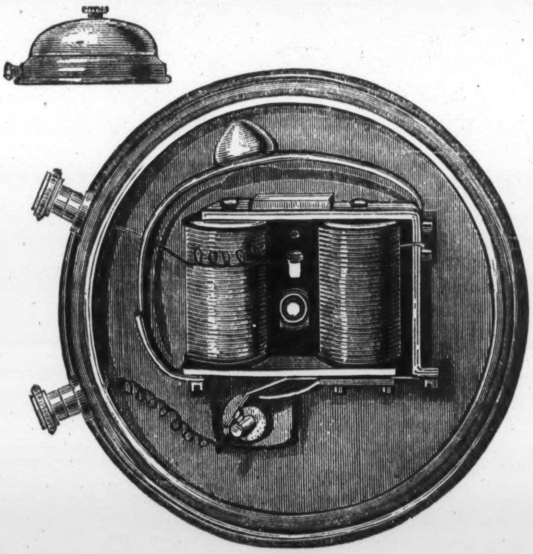
The column had a total height of 55 centimetres and a diameter of 15 centimetres. For the construction of the secondary generator were required 20 kilos of copper, and hence a cost of 60 francs—a very small outlay for an apparatus capable of feeding 18 to 20 lamps at 16 normal candles. This price is trifling in comparison with that of accumulators.

A closer examination and a more frequent application of this apparatus will best show its value.

The communication made by Tresca to the Academy of Sciences on the Turin experiments was characterised by great reserve. It closed as follows:—"The purpose of the statements made is merely to show that it has been found perfectly possible to carry out several methods of illumination in a circuit extending to 40 kilometres from the place where the current is produced. The importance of this fact demands the verification of the data concerned. It must be remarked that we have nothing to do here with a transfer of mechanical power."—*Zeitschrift für Elektrotechnik.*

THE DE REDON BELL.

THIS bell, of which a plan (with the dome removed) is shown by the fig., is extremely compact in form, and has the decided advantage that it will ring in any position. The arrangements of the parts are very ingenious. The bell knob, instead of being placed at the end of a rod projecting from the end of the armature, as is usual, is fixed to the side of a curved spring. One end of the latter is fixed to the end of the armature (which is arranged in the usual manner), and the other end is fixed to a corner of the magnet frame, as shown. The action of the bell does not require explanation. One feature in the apparatus is the arrangement of the make and break portion, which ensures a good rubbing contact.



Electric Lighting of Railway Carriages.—An experiment of lighting trains with electricity was made on the South Eastern Railway on December 30th, two trains each way between London and Maidstone being provided with incandscence lamps. The experiment proved very successful.

THE "SUN" LAMP.

[A COMMUNICATION.]

(Continued from page 6.)

The 20 lamps to be used for the Grosvenor Gallery will be self-lighting lamps of this last type.

The hand lamps in their present form have the same system of lighting as the automatic ones. Only the raising of the weight of 1,500 grammes is performed by hand. The weight is suspended on a chain, and may descend to be easily reached at whatever height the lamp may be. The recoil can also be regulated in this case, and there is no longer the risk of too sudden lighting. This lamp costs less than the automatic one.

Lastly, the workshop type comprises no more than the case and two pushing springs. The lamp is lowered to be lighted, the small carbon being worked by hand. This lamp is of the simplest type possible and is also the least expensive. We see thus that each model is very complete and answers its purpose well, the price being in proportion to the commodity.

Various attempts have been made to substitute for the marble a body offering more resistance to damp than lime does. This has always been tried with magnesia. The light is much less brilliant, which fact has discouraged the inventors from proceeding with their endeavours.

When magnesia is obtained at a low price, there will be an economical advantage. The lamp will be made with rather long carbons so as to last several weeks, and these advantages will compensate for the comparative dulness of the light. In another way perhaps the employment of magnesia may be increased.

M. Clerc has shown that if we pierce a hole in the marble to arrive at the centre of the arc and blow air through the aperture the arc is projected beyond the marble, and the light is greatly increased. If instead of air, gas is blown through and especially hydrogen, the light is more than trebled. If the block is sufficiently hollowed out, this lamp burns without any inconvenience. The illuminated area is much more considerable, and the colour magnificent. The increase in force necessary is only 25 per cent. As in this case the block no longer serves to produce any light but only to stop the carbons, magnesia would be perfect. This arrangement involves a little extra expense in the installation; but the advantages are so great that this kind of lamp cannot fail to come into favour.

For a long time endeavours have been made to find out what length of arc is best as regards efficiency. M. Clerc showed, about April, 1882, that the arc only increases as a resistance 2 per cent. per millimetre of marble placed between the carbons, whereas from 10 millimetres to 30 millimetres the light increases about from 1 to 3. The question is therefore settled; it is best to have the arc from 25 to 30 millimetres, which is the dimension adopted in London by the Sun Lamp Company. As regards intensity, the highest gives the best rendering. M. Clerc, in fact, showed that the resistance of the lamp varied in the proportion $\frac{K}{I\sqrt{I}}$ which shows that the work varies in the ratio of $\sqrt{I}$, which conclusion has since been confirmed by the Wattmeter.

As the light varies in the ratio of I, we see that the rendering increases quickly with I. But with marble we cannot exceed certain intensities. Experiment shows that about 12 ampères is a practical maximum. Higher intensities can be employed, 16, 20 and even 25 ampères, but the marble does not last nearly so long. It is best to use 12 ampères with 30 millimetres of arc. This gives 2,200 candles, and, as we shall see later on, the mechanical and electrical work does not exceed 2 H.P. per lamp. We get, therefore, 1,100 candles per H.P. With this rendering and the cylindrical boring of the marble, the useful effect of the Sun Lamp is considerable. There is, however, one respect in which force can be economised; *i.e.*, on the carbon.

As it has been established, the work in every arc consists of the work due to the formation of the arc and that due to its length. In the Sun Lamp the work due to the formation of the arc is very important owing to the large dimensions of the carbons which, although protected against the cold, heat very slowly and render the formation of the arc difficult. In ordinary lamps the section of the carbon is 4 millimetres per ampère. In the Jablochkoff candle it is $1\frac{1}{2}$ m. In the Sun Lamp it is 30 millimetres per ampère. This is why the linear consumption is so slight, although economy is also observed in the carbon burnt by combustion in other lamps. With the ordinary arrangement, the diameter of the carbons cannot be reduced, as they would then burn the marble too much owing to their greater heat.

We must therefore turn our attention to the composition of the carbon. The more compact the carbon is, the less easily is it heated, for the heat of the part in which the arc is formed easily spreads into the carbon. We require, therefore, a very soft carbon that is a bad conductor of heat. Messrs. Varley have made for the Sun Lamp some carbons of carburetted silk which answered this purpose. The force required by two similar lamps placed in the same circuit, the one having ordinary carbons and the other the Varley carbons, showed that the latter gave an economy of force of 20 per cent.; the light was weaker. The rendering seemed little increased.

In order to employ small carbons, the intensity must be diminished, so that the marble is less easily penetrated. With 4 ampères, we can employ carbons of 6 millimetres consuming at the rate of 10 millimetres per hour—with an arc of 10 millimetres we get a light of 200 candles, requiring 0·5 H.P. as mechanical and electrical work.

These lamps are suitable for small spaces, although giving about half the rendering of the larger ones, and for industrial purposes may be extensively used.

The Sun Lamp with a constant distance between the carbons is polyfocal, and as there is no mechanism, even for regulating the advance of the carbons, no perturbation is possible, and a large number of lamps can be placed on the same circuit without inconvenience, especially when lighted with the regulated recoil.

However high may be the tension employed in the circuit, there is no danger in handling the lamps even while they are at work. In fact, if it is necessary to attend to a lamp that has been overlooked, and that while they are in action, each lamp is provided with a double cut-off, which introduces a short circuit in the place of the lamp, and at the same time completely insulates from the circuit the two wires conducting the current to the lamp, which can then be touched without the slightest danger. The double cut-off constructed by M. Clerc acts by means of a heavy weight placed above the axis of oscillation. This weight falls either to the right or left, making short circuit, or allowing the lamp to burn, but it cannot remain in this intermediate position. It is therefore placed on the top of the lamp and worked from a distance with perfect safety. We thus realise in many cases an economy of wire, and the installation is more easily managed, and cleaner.

The Sun Lamps can therefore be placed in large numbers on a circuit; but can it burn in parallel?

In ordinary form the lamp is one with the distance between the carbons constant, and not regulated. As in all lamps of this nature, its resistance diminishes rapidly when I increases. Thus, a lamp placed on an Edison machine of 100 volts increases in intensity from 15 to 50 ampères, and then the marble melts. In fact, at 15 ampères, if the resistance tends to diminish, the intensity increases, then the resistance diminishes again, and so on.

In order to burn, the lamp requires a regulated current as produced by some dynamos, or a current regulator—this might be a wire, which, placed on the circuit of the lamp, becomes heated when the intensity increases, and increasing in its resistance corrects the diminution in resistance of the lamp due to the increase of intensity, and *vice versâ*—or it might be an electrical regulator. By placing on the same derivation with each lamp a thin iron wire Prof. Garnett, of Nottingham, burnt some Sun lamps in parallel with some incandescence lamps from a Ferranti machine.

At the present day, with an alternating current machine, we should employ special bobbins, such as those of Mr. Gordon. With an electrical regulator M. Clerc for several evenings worked a Sun Lamp at the Exhibition on an Edison circuit supplying 600 Edison lamps.

These regulating apparatus absorb a considerable amount of force, from 20 to 25 per cent. It is possible, however, to work a Sun Lamp without sustaining this loss. To do this it is sufficient to make one of the carbons smaller and movable, and to regulate it by a coil placed after the lamp on the same derivation.

As the resistance of the lamp decreases, the coil draws back the carbon, and *vice versa.* This type of lamp is monofocal, and to be used with a direct current, as the coil in that case can be kept in the circuit without taking a noticeable amount of power, as it was the case with alternating current. The movable carbon will be the negative one which, in the Sun Lamp, does not consume at all, as we see the movable carbon is impinged by a weight which can be regulated so as to obtain the required intensity.

When placed in a circuit of constant potential this arrangement will keep the carbon in the proper position to maintain a constant intensity.

This model will be used with all direct dynamos giving a current of 90 volts or more—whether the dynamo is made for one lamp only, or for a given number to be worked in parallel circuit.

In the latter case, if some lamps have to be lighted independently of the others, the switch of each of them must be fitted with a small resistance coil, to prevent the other lamps being affected when the carbons are brought into contact to light the lamp.

This type of lamp will be fit to be placed in the circuit of the dynamos working incandescent lamps. Each of such lamps burning with 10 ampères and 100 volts will require the same power as 12 incandescent lamps, and give seven to eight times more light.

The light of the Sun Lamp being steadier than that of incandescent lamps, as it is less affected by the variations of speed of the motor, and the tone of the light being less reddish, it may be used in preference in many cases, specially when incandescent lamps are intended to be used in lustres.

If series direct-current dynamos be used the lamps must be polyfocal, and the coil moving the carbon is wound with thin wire, and shunted on the lamp. In this case the coil impinges the carbon when the resistance increases, and the regulating weight is used to draw the carbon back. If in this case the lamps are intended to be lighted separately, a second coil is used to push the movable carbon rapidly in contact with the other. This last coil wound with thick wire is at the same time the resistance of the safety switch, which we have described before.

As soon as the contact is formed this second coil is cut out, the movable carbon is drawn back by the weight, and the shunted coil will alone regulate the position of that carbon. Such an arrangement may be used with all ordinary arc lamps.

The Sun Lamp, either with a constant distance between the carbons, or with one of them movable, can be used with nearly all dynamos in use, provided the current be from 90 to 120 volts per lamp, the intensity being from 8 to 14 ampères.

Let us now consider specially the type of lamp most in use, *i.e.*, with constant distance between the carbons, and discuss the dynamos used to work it.

As we have seen that the resistance of these lamps diminishes in the inverse ratio of $I\sqrt{I}$, like all lamps of fixed distance between the carbons, and that it cannot be regulated, it is the machine that must serve as regulator and maintain the intensity. With alternating current machines, this regulating is effected more or less by the machine, according to its nature, as in all alternating current machines the electromotive force increases with the external resistance, thus regulating the variations in resistance of the lamp. In continuous current machines having the inductor and the induced part on the same circuit, the machine no longer regulates, but, on the contrary, is very much affected by the variations in the lamp. With the least slipping the lamp cannot burn, and a large increase of speed is necessary or a wire serving as a regulator is introduced into the circuit. Otherwise, if the lamp increases in resistance, the intensity is diminished, the inductor becomes weakened, and so on until extinction ensues.

In order to burn with continuous currents, shunted machines are necessary. In this case, if the resistance of the circuit increases, the inductor becomes stronger, and the lamp or lamps are regulated.

With machines of this kind at 10 ampères the lamp works very well.

With the Brush machine the lamp works pretty well, although the machine is not sufficiently shunted.

Thus we can employ either the continuous current or the alternating current at will. For small installations continuous current machines are undoubtedly the best. For high tensions continuous current machines are more difficult to attend to on account of the collector, and because of the danger of the extra current in case the circuit is broken. Besides, continuous current machines cannot be adapted to division like alternating current ones. Lastly, as we shall see later on, the force taken will be important as a guide to us.

The alternating current machines employed up to now have been those of Gramme, Lachaussée, and Maquaire. But none of these suit the Sun Lamp so well as that of the inventors of the lamp—Clerc and Bureau. Having observed that machines having their wire perpendicular to the axis of rotation (Lachaussée and Maquaire) were much more noisy than those having their wire parallel to this axis, which is easily explained by the more sudden magnetisation and demagnetisation, M. Clerc endeavoured to construct a machine with its wire parallel to the axis of rotation.

Having examined the advantages of the Pacinotti rings he decided on a machine of this type. In order to allow of the use of powerful inductors he was obliged to make the soft iron core of insulated iron wires. It was in this order of ideas that in December, 1882, he constructed the coil mentioned in *Engineering*, of the 17th October, 1884.

He wound on a wooden core in two pieces some insulated iron wire, fixing each layer with strong glue. Then cutting the iron wire with the saw he obtained two solid armatures in the form of a horse-shoe. On these armatures he wound the wire, and thus formed the coil.

In conjunction with M. Bureau he then constructed the machine described in the same number of *Engineering*, which fed 25 lamps of 25 millimetres at 10 ampères at the Health Exhibition, and which was patented in June, 1883.

In this machine all the coils are homologous, and can be joined either in quantity or in tension, all together or separately. Homologous coils are indispensable for incandescence, secondary generators, and for easy combination of arc lamp circuits. In this machine the coils are all insulated from one another completely, and also from the frame of the machine. The inductor is revolving, which allows constant attention to the armature. This is a very important consideration.

Lastly, each bobbin is easily taken off and replaced, even when at work, for it is only necessary to withdraw four screws, which is also a very important matter in extensive lighting.

Each coil has its wires attached to two fixed terminals mounted on wood at the side of the machine. The wires of all these terminals are connected with a commutator fixed to the side of the machine, on which the groupings are easily performed.

Under these conditions the Clerc and Bureau machine should work well, and has made a succesful *début*, as it has been worked for four months at the Health Exhibition without the slightest hitch.

Let us now examine the electrical conditions of this machine.

In alternating current machines the armatures of the inductor act upon the bobbins in two ways :

By the action of the lines of force on the wire. By the magnetic attraction.

In the Siemens alternating machines the only action is that of the lines of force, for there is no soft iron in the induced coils.

In the Gramme alternating machines the action is similar notwithstanding the ring of soft iron, for there is no magnetic action.

In the machines used in connection with the Wilde system there is, on the contrary, only the magnetic action.

In the machines of Lachaussée, Maquaire, Clerc and Bureau, there is the combined action of the two effects.

In the machines where there is only an action on the wire, the intensity varies enormously with the external resistance, and if this resistance becomes too weak, the machine gets heated and burnt.

In the machines of the Wilde type the intensity remains constant whatever may be the external resistance; but if it becomes too great, the machine gets heated and burns.

The Lachaussée-Maquaire machines are like the former ones and get heated if the resistance of the circuit becomes too slight.

The Clerc and Bureau machine occupies an intermediate position.

It does not get heated either on short circuit or in open circuit, and the intensity varies very slightly with the external resistance. When short circuited a machine of 12 lamps indicates 12 ampères, and when the 12 lamps are lighted, the intensity is 10·5.

In no case can any accident be caused to the machine, which is the practical desideratum, for we can make in the circuit all the variations required by the number of lamps to be lighted.

There has been much discussion as to whether or not the magnetic action should be utilised.

The action of the soft iron effects a considerable saving in the first cost. Thus, a Lachaussée bobbin which gives a lamp of 10 ampères, no longer does so if the soft iron is taken away, in which case the machine becomes a Siemens machine and only gives a lamp of 7 ampères. As to rendering, the question is more complex. *A priori*, we understand that the soft iron should be employed in the form of insulated iron wires to avoid as far as possible Foucault's currents, which heat and cause a loss of work.

If the machines without soft iron have no Foucault currents, on the other hand, the action of the lines of force can only be exercised on one part of the wire, and with difficulty on more than half as in the Gramme and Siemens machines; hence the internal resistance is too great.

Besides, there are appreciable differential actions according to the position of the armature. This is what renders it essential in the Gramme machine to form two circuits not of the same nature. When, on the contrary, there is magnetic action, the reaction of the soft iron acts on the whole of the wire surrounding it, and there is much greater unity of action.

We think that in the future preference will be given to the machines joining the two effects and avoiding Foucault currents as far as possible. This is the case with the Clerc and Bureau machine.

With a length of copper wire of 3,600 metres, a machine excited with 25 ampères supplies 24 lamps of 9 ampères at 1,000 revolutions. At the same speed a Gramme machine excited with 25 ampères, having 2,700 metres of wire, works 10 lamps of 9 ampères (as in the South Kensington Museum).

A Clerc and Bureau machine therefore works one lamp of 25 millimetres at 9 ampères per 150 metres of coiled wire. When excited to the same extent, a Gramme will give a similar lamp with 270 metres of wire.

If the machine is excited with 28 ampères it can work 25 lamps, 21 lamps at 10$\frac{1}{2}$ ampères and 4 at 9$\frac{1}{2}$. Seven bobbins supply 3 lamps per bobbin. One bobbin supplies 4 lamps. Thus, when excited with 28 ampères the Clerc and Bureau machine can maintain 32 lamps, or one lamp per 120 metres of coiled wire. This shows the considerable economy of wire. As to the rendering, diagrams alone can enable us to form a decisive opinion, but we think that soft iron employed, as in the Clerc and Bureau machine, can only increase it. In fact, under these conditions, the machine approaches the Pacinotti type, the superiority of which has been established by Professor S. Thompson. If the Clerc and Bureau machine is very complete as regards external variations, it cannot guard against variations in the speed of the motor, nor can any dynamo. To do this, M. Clerc employed a regulator of intensity.

The exciter is run at an excess of speed, and a resistance is placed permanently in the circuit.

In 1879 M. Clerc, when lighting up the railway station at Antwerp, made use of the following arrangement :—The resistance was a hand rheostat ; the resistance was corrected according to the requirement, whether the machine became too much heated or not sufficiently so, and for the first time the lighting with the Jablochkoff candles attained the desired safety. It is this principle that has been applied to the regulator of intensity. A coil moving a soft iron core causes the interposed resistance to vary, and thus corrects the variations of the motor.

Many models have been tried in combination with the Sun Lamp. The simplest and most efficacious is that proposed by M. Clerc, having the resistance in the form of a helix, in order that the variations in resistance may be progressive, for sudden variations put the machine out of order.

Now the resistance is fixed and thus arranged. An apparatus, similar to the collectors of the machines, and hollow in the centre, is placed in an ebonite vessel. The teeth in this apparatus form on their under part a helix, so that the mercury touches in succession all the teeth ; between the teeth are put the divisions, the sum of which represents the resistance. An iron piston moved by the coil, descends into the vessel and regulates the current. A projecting counterpoise corrects the increase of weight when the piston rises out of the mercury.

The bobbin and the soft iron core are long, and, for a difference of $\frac{1}{4}$ of an ampère, the apparatus, which is regulated to the required intensity by the weight adds, or takes away all the resistance which corrects the variations in speed within 20 per cent.

In this last model, instead of being placed on the circuit of the exciter, the resistance is placed in derivation on the inductor of the exciter. Thus a considerable part of the work of the exciter is saved.

The Sun Lamp has, therefore, now, apparatus and dynamos as perfect as possible. Before commencing a fresh part on the subject, M. Clerc wishes to mention how valuable the collaboration of M. Duchamps has been to him in the improvements effected.

We are now about to commence an important chapter ; viz., that treating of the force required, and here again we shall have some useful observations to mention, especially as regards electrical measurements.

(*To be continued.*)

Expected Strike of Telegraph Operators.—For some time it has been rumoured that the telegraph operators of America at large are contemplating another strike. The recent memorable strike has, the operators as a body say, taught them the value of organisation as an important factor in such a movement. Say the operators : "The Western Union makes prices, controls men, and holds its *employés* under its thumb. This big grasper of money and absorber of poorly-paid toil must be brought to terms."

THE THERMO-DYNAMIC POTENTIAL AND THE THEORY OF THE VOLTAIC BATTERY.

M. P. DUHEM.

VERY simple reasoning, based on the ideas introduced into thermo-dynamics by Clausius, shows us that the heat evolved in any isothermic modification whatever consists of two portions, the one, equivalent to the work compensated, and the other to the work not compensated. This latter portion is nil if the modification is reversible, and necessarily positive in the contrary case.

Hence the following theorem may be readily deduced: in order that a system may be in stable equilibrium, it is sufficient that every virtual isothermic modification of this system shall correspond to an uncompensated or negative work. This theorem recalls the principle of virtual velocities, which it includes as a special case.

Whenever the exterior forces admit a potential, P, the uncompensated work itself is the variation (changed in sign) of a function.

$$\Phi = E(U - TS) + P.$$

U being the internal energy, S the entropism, T the absolute temperature, and E the mechanical equivalent of heat. For this function, Φ, we propose the name of thermo-dynamic potential. When a system admits a thermo-dynamic potential it is sufficient, in order to determine the state of equilibrium of this system at a given temperature, to seek out under what conditions the thermo-dynamic potential is a minimum at a given temperature. This theorem has been indicated, though in a less general form, by M. Gibbs and Prof. Helmholtz.

By this method, which in the study of thermodynamics dispenses with the long and troublesome consideration of the cycles, we may summarise, in a single theory, all the results hitherto obtained in applying the theory of heat to changes of condition, physical or chemical, and a considerable number of new results. We may, in the study of capillarity, get rid of the objections which spring from the possibility of a change of state of the liquid near the terminal surfaces, and at the same time give a complete theory of the retardation of boiling, of superfusion, &c. But these results are too numerous to be summed up, even briefly in this note.

The theory of the thermo-dynamic potential is applicable to electric phenomena. The thermo-dynamic equivalent of any electrified system whatever the different points of which are immovable,may be calculated by merely making use of the law of Coulomb and of that of Ampère for closed and uniform currents. The study of this potential gives in electrostatics the theory of the differences of potential at the contact of the two metals, of Peltier's phenomenon, of electric expansion, &c. By combining with it the law of Joule relative to the heating of conductors we may obtain a complete theory of the voltaic battery, the chief results of which we are about to indicate.

The chemical reaction which is produced in the elements would furnish, if not collected by the current, a quantity of heat compensated, Q, and a quantity of heat not compensated, Q^1. We may demonstrate with precision the following theorems:—

The heat liberated in the battery when in action is equal to $Q + Q^1$.

The voltaic heat, that is to say the quantity, A, r, i^2 (in which r represents the resistance of the circuit, i the intensity of the current) is equal to the uncompensated heat, Q^1.

The excess of the chemical heat over the voltaic heat is therefore equal to the positive or negative quantity, Q.

Thus there is a complete explanation of the difference, pointed out by Favre, and subsequently by a number of observers, between the chemical and the voltaic heat.

The first idea of this theory of the battery is due to Prof. H. von Helmholtz, but this illustrious physicist omitted to support this idea by a rigorous demonstration. He certainly submitted it to the test of experiment, showing that in certain batteries, the activity of which is due solely to the difference of concentration of two solutions, the electromotive force may be calculated from a knowledge of the vapour tensions of these solutions. The theory of the thermo-dynamic potential leads in an almost direct manner to the formulæ of Helmholtz.

The new theory of the battery enables us to find the numerical values of the two kinds of quantities of heat which a chemical reaction liberates, and to compare the part played by these two quantities.

The uncompensated heat being annulled in the moment of equilibrium it is not doubtful that in reactions bordering upon equilibrium, and consequently of little energy, the total heat will especially represent the compensated heat. It cannot be the same in reactions widely removed from a state of equilibrium, and consequently very energetic. An experiment made with the battery shows us, then, that the uncompensated heat constitutes the larger portion of the total heat liberated by the reaction.

If we regard the total heat as an approximate measure of the uncompensated heat, the fundamental theorem enunciated at the beginning of this paper becomes the total principle of thermo-chemistry. We may thus understand how this principle is applicable with such success to energetic chemical reactions, whilst in reactions bordering on a state of equilibrium submitted to the laws of dissociation it is often, as M. Debray and other chemists have remarked, at variance with facts.—*Comptes Rendus.*

EDISON'S THREE-WIRE SYSTEM OF DISTRIBUTION.

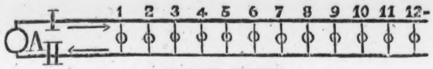
THIS arrangement of connecting up dynamo-electrical machines, devised independently both by Mr. Edison in America and by Dr. Hopkinson in this country, has already been described and in other ways alluded to in our columns.

Two of our transatlantic contemporaries have recently been dealing with this subject in a way which we feel sure would be of interest to our readers, and we, therefore, reproduce below the substance of the articles contained therein. Mr. H. M. Paul, who is responsible for a short paper in *Science*, says:—

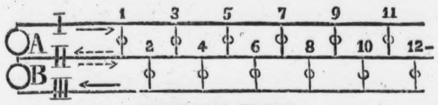
"The size of the conductor must be proportioned to the maximum number of lamps which it will ordinarily supply. This number being given, the size should be such that the resistance of the metallic part shall bear a fixed ratio to that of the lamp part of the circuit; and the value of this ratio will be determined by the condition that the additional running expense due to the resistance of the conductor shall equal the interest on its first cost, so far as this depends upon its cross-section.

"In the two-wire system A is the dynamo, which we will suppose to keep up a difference of potential of 100 volts between the conductors I and II. Across these are bridged 12 lamps of equal resistance, representing what would be in practice several hundred dwellings, factories, churches, theatres, &c.

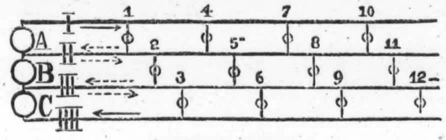
"The next figure shows Edison's three-wire modification of this. A and B are two dynamos coupled in series, with conductors I, II, and III leading out as shown. As A and B each keep up 100 volts, as before, the difference of potential between I and III will be 200 volts. The 12 lamps are now, however, equally divided between the circuits I-II and II-III, connected as shown. If the resistance of the six odd-numbered lamps, 1-11, exactly equals that of the six even-numbered, 2-12, and if A and B keep up the same difference of potential, no current will flow in II, between the dynamos and where the first lamp joins it. Suppose II to be cut, there will then be a single circuit through A and B, I and III, and the 12 lamps, as shown, with a difference of 200 volts in I and III. The resistance of the 12 lamps, as now arranged, will be four times what it was before; and hence only one-half as much current will flow through I and III. But each of the lamps will get just as much as before, and will shine the same. The conductors I and III, since the resistance is now four times as great, need only be one-fourth as heavy, according to our adopted principle. This is also proper as regards heating effect in them, which, proportional to the square of the current, is now only one-fourth what it was before.



TWO-WIRE SYSTEM



THREE-WIRE SYSTEM



FOUR-WIRE SYSTEM.

"If this were all that was needed we should now have the same amount of lighting done, and the conducting mains, which are the most expensive part of the plant, of only one-fourth their size and cost in the two-wire system, and with only the additional expense of another dynamo. Moreover, since the current is only one-half as much, these two dynamos, though giving the same potential as before, can be smaller. But on account of the difficulty in keeping an exact balance in the two sets of lamps, especially about the time of lighting up at twilight, it is necessary to introduce the third conductor from between the two dynamos, and then neither circuit can be exposed to a difference of potential greater than either dynamo is generating. Also, if the balance is not kept, a current through II, and a galvanometer, shows on which side the lamp resistance or the dynamo potential is in excess; and Edison restores the balance by variable resistances in the circuits of the field-magnets, or, in some cases, by bringing an extra conductor from one or two large buildings, like factories, theatres, &c., when near by, so that they can, at will, be thrown into either circuit from the central station.

"This middle wire need not, for most purposes, be so large as the other two, but in the case of a breakdown of I or III it will have to do equal work with the other, so that it is safer, simpler, and better to make them all of the same size. The cost then of conductors is that of three wires, each of one-fourth the section of the two in the first case, or $\frac{3}{2} \cdot \frac{1}{4} = \cdot 375$, or a saving of $62\frac{1}{2}$ per cent.

"The four-wire system shows a still further reduction of expense. The law on which this percentage of economy proceeds, as far as cost of conductors is concerned, may be shown as follows, in units of the cost of the two-wire system:—

For 2 wires, we have, $\frac{2}{2}\left(\frac{1}{1}\right)^2 = 1{\cdot}000$
" 3 " " " $\frac{3}{2}\left(\frac{1}{2}\right)^2 = \cdot 375$
" 4 " " " $\frac{4}{2}\left(\frac{1}{3}\right)^2 = \cdot 222$
" 5 " " " $\frac{5}{2}\left(\frac{1}{4}\right)^2 = \cdot 156$
" 6 " " " $\frac{6}{2}\left(\frac{1}{5}\right)^2 = \cdot 120$

"A limit of economy or practicability, however, will soon be reached in the increased number of dynamos, the complexity of the system, and especially in keeping up an approximate balance between so many circuits. In practice, probably, the three-wire system, with its saving of ·625 of the cost of the two-wire, will be found all-sufficient; except, perhaps, in the case of a long main through a large scattering district, when the four or five-wire plan might be preferable."

A writer in the *American Engineer* deals with the matter in a somewhat different manner, as follows:—

"Fig. 1 represents the original system of distribution; D is the dynamo, A and B the main conductors between which are placed, we will suppose, six lamps as indicated. If E is the difference of potential maintained by the generator between the two conductors, r the combined resistance of the lamps in multiple arc, and R that of the conductors, then

$$C = \frac{E}{r + R}$$

for the current through the conducting system of mains and lamps.

FIG. 1.

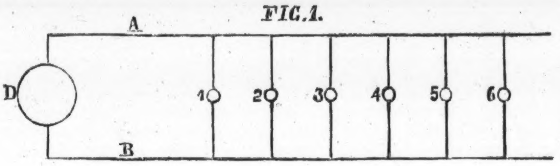
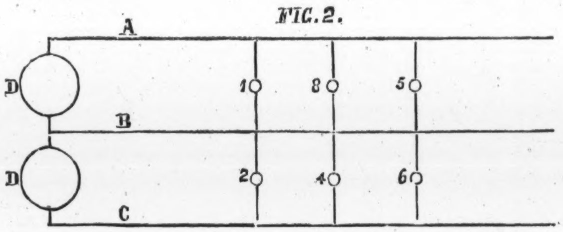


FIG. 2.



"Fig. 2 illustrates the three-wire plan of distribution, in which two similar dynamos, D, D, are employed in series. A, B, and C, are the conductors, and the same number of lamps is employed as before. The same difference of potential is maintained between either two adjacent conductors as between A and B in the former case. If the resistance of the lamps 1, 3, 5 is the same as 2, 4, 6, the difference of potential between the two ends of B will be zero, and no current will traverse it. We may suppose B removed for the time being. The resistance of the lamps from one main to the other is now four times as great as in the former case; for there are only half as many paths for the current to pass across, and each path has double the resistance, the lamps being supposed exactly similar. In order that the lamps may furnish as much light as in the plan of fig. 1, the total energy of the current should remain the same, provided the same ratio subsists between the resistance of the lamps and of the leading wires. The energy is the product, C, E. But the E.M.F. is now doubled; and to maintain the product of E and C constant while E is doubled, C must be halved. Therefore the resistance of the conductors can be increased four-fold, or their size reduced to one-fourth, because then

$$C' = \frac{2\,E}{4\,r + 4\,R} = \frac{1}{2}\,\frac{E}{r + R} = \frac{1}{2}\,C.$$

"The total cross-section of the three conductors, as compared with the former two, is $\frac{3}{2} \times \frac{1}{4} = \frac{3}{8}$, a saving of 62·5 per cent.

"The object of introducing the third conductor, B, is two-fold; first, to make each lamp independent, so that if one fails the others will still be supplied with the necessary current; second, to provide that no lamp be exposed to a greater difference of potential than that due to either dynamo. It follows that each lamp will be maintained at the same candle-power as in the old plan if the difference of potential between its terminals remains the same. This appears also if we consider that there are half the number of paths across from A to C when B is idle; there is also half the total current. Hence the current by each path is the same as in fig. 1. A constant current is the condition that a lamp shall convert a constant amount of the energy of the current into heat, since the expression for this energy is $C^2 R$.

"It is evident, however, that this arrangement does not secure the maximum economy corresponding to the results which we obtained for the most economical size of a conductor. It has been shown that the cross-section of the conductor should be proportional to the current strength. In the case before us the current is reduced one-half, while the conductors are diminished to one-fourth their former size. In the arrangement adopted by Edison, the ratio between the energy consumed by the lamps and that wasted in the conductors remains the same in the two cases, the two classes of resistance being increased four-fold each. The additional running expense due to heat waste in the conductors is not diminished in the least, while the cost of the conductors is diminished to three-eights the former amount. If the principle is a good one that the most economical size of a conductor is attained when the loss by heating it equals the interest on its first cost, then clearly such a condition is not realised in the three-wire system, provided it is applied in determining the size of conductors in the old two-wire plan. The current being reduced 50 per cent., the size of the conductors should be reduced only the same fractional part. The E.M.F. required to maintain this current would then be less than $2E$. In other words, the two dynamos could then be made smaller, and could furnish a somewhat lower E.M.F. In the first case, fig. 1, the equation for the current gives $E = C r + C R$.

"If the size of the conductors were reduced only one-half, we should have

$$\tfrac{1}{2} C = \frac{2 E'}{4 r + 2 R}$$

"Whence $E' = C r + \frac{1}{2} C R$ for the E.M.F. of each dynamo. So arranged, the three-wire system would secure a gain of 25 per cent. in cost of conductors, and a further gain in reduction of running expenses. This gain is readily estimated. The energy expended in the three-wire system with conductors reduced three-fourths in size is:

$$\tfrac{1}{2} C \times 2 E = C (C r + C R) = C^2 r + C^2 R,$$

of which the first term is the energy spent upon the lamps, and the second denotes the waste upon the conductors. The energy expended with conductors reduced one-half in size is:

$$\tfrac{1}{2} C \times 2 E' = C (C r + \tfrac{1}{2} C R) = C^2 r + \tfrac{1}{2} C^2 R.$$

"From this it appears that the energy absorbed by the lamps is the same as before, while the energy wasted in the conductors is reduced to one-half its value in either of the other plans. The three-wire system, as arranged by Edison, permits of a saving of the interest on 62·5 per cent. of the cost of the copper conductor. A three-wire system with a reduction of one-half in the size of the conductors allows a reduction of interest on 25 per cent. of the cost of conductors, and of 50 per cent. of the running expenses due to heat waste, or a total of 75 per cent. of the interest on cost of conductors, a gain of 12·5 per cent. A further advantage to be derived from the reduction of the conductors to only half their original size, as compared with the reduction to one-fourth, is the lower temperature to which they will be exposed. With conductors reduced one-half in sectional area, the energy expended upon them, and therefore the heat developed, are only half the amount involved in either of the other arrangements; the thermal capacity of the wire being also half as great as in the two-wire system, the rise of temperature will be just the same. But if the conductors are reduced to one-fourth their original dimensions, while the quantity of heat generated in them remains the same, the rise of temperature will be four times as great as the two-wire plan.

"We submit the question then, whether Mr. Edison has not sacrificed a portion of the advantage legitimately belonging to his device by attempting too great a saving in the cost of conductors."

SECONDARY BATTERIES.

IN a recent number of *Engineering*, the correspondence to which we have already adverted is resumed, "Electrolyte" saying, in answer to Mr. Sellon's letter:—"Respecting his claim to roughening plates, there are manifestly several ways of doing this. The plate may be roughened by scratching, as is sometimes done. It may be made by casting on a rough surface. It may be corroded by immersion in nitro-sulphuric acid (not nitric acid alone, as Mr. Sellon states, and this appears to make a great difference) like Messrs. Parker and Elwell; or, as by Planté's method, the surface may be eaten into by the alternate electrolytic oxidation and reduction of juxtaposed plates in a bath of dilute sulphuric acid. In view of all these various modes of action, I think the method used requires at least some specific description, or, anyhow, more than mere general allusion. Now the last-named process was minutely described by Planté, who specially bears upon it in his directions for the construction of his cells, and although I am not aware that he ever took any *patent* in this country, still his paper to the Academy of Sciences was widely made public here, and I read the whole account published in English at the time of the first appearance of the Faure battery, long before Mr. Sellon had ever taken a patent for secondary batteries. His claim to priority therefore falls to the ground. Had Mr. Sellon limited his claim to any *one* kind of roughening differing from that of Planté and not previously published, I can imagine that he might have formulated a holding claim; but as it is, with its attempted comprehensiveness, it becomes *nil*, and is but one more illustration of the truth of the old adage, '*qui trop embrasse mal étreint.*' Again, an example of insufficient protection through loose wording is to be found in his patent, No. 2818, 1882. He there specifies in particular the fashioning of plates with conical holes, which he fills with the active material, or to speak more exactly, gives to these holes shapes which he illustrates by drawings, so that the active material may 'keylock' into them, and be prevented from falling out. Now this in the first place obliges Mr. Sellon to use plates of considerable thickness, accounting in some measure for the great weight of his battery, and in the next it does not obviate the use of straight holes with sheets of felt or some other arrangement to prevent the cylinders of active material from falling out if employed by any designing persons wishing to evade his patent. In face of the illustrative drawings, which prove Mr. Sellon never to have entertained such an idea, it is doubtful whether he could even plausibly uphold an attack for infringement against any one using pegs of active material with heads like nails stuck in a plate with holes to fit them. As to the second point which Mr. Sellon raises, viz., the comparison of the Faure-Sellon and the Parker-Elwell batteries. I am not able to speak with enough certainty as to their respective working to be able to pronounce upon the figures Mr. Sellon gives, but corroborated as they are by the letter of so great an authority as Mr. Reckenzaun, of course I look on them as both impartial and moderate. They do not, however, prove so much that the former gives a high efficiency as how lamentably deficient the latter is in this respect. This must and will always be the case, I fear, while we are driven to use a metal of so high an atomic weight as lead to produce the active material of secondary batteries. We can only, while this is so, aspire to reducing the weight of the support. I suppose the preference of some electricians for the Parker-Elwell battery lies in the fact that it is particularly useful where a rapid discharge of high power is desirable, for in this respect I have understood it excels all others. Also I have heard complaints that the Faure-Sellon battery rather loses with age, whereas the Parker-Elwell gains thereby. Also that the studs of active material swell and then get loose and drop out in the Faure-Sellon battery. I do not know whether these complaints are well founded, but as my authority is a very high one I am prone to credit it."

Mr. Sellon, replying to the preceding letter by "Electrolyte," remarks that the latter "has fallen into an error—I can fully believe an unintentional one—which, however, governs the chief of his premises. He states that M. Planté's paper to the Academy of Sciences was read and published *before* I had taken out any of my secondary battery patents. The date of my first patent (the one referred to throughout this correspondence) is 10th September, 1881. M. Planté's patent was taken out nearly a year later, viz., 11th July, 1882, and his paper to the Academy of Sciences was read August 28th of same year. Other points of 'Electrolyte's' letter are equally (I have no doubt as unintentionally) at variance with facts, but before being at the pains of discussing them for his edification or that of others who may be interested with him, I would ask him as a matter of courtesy to favour me with his name."

Mr. F. Geere Howard writes:—"In the correspondence now going on between two rival secondary battery manufacturers, there seems to be an endeavour to prove that *their* particular form of cell is the better, both as regards weight and efficiency. Now I have found that a great variety of accumulators are required, and that no one form in the market is suitable for all requirements. For example, when they are used simply as a safeguard against a temporary breakdown in an installation through the breaking of a belt or the heating of a bearing, all that is required is a battery that has a very high discharge for a short period. Now the 'Elwell-Parker,' or properly "Planté" type, *will do this* and the "Sellon" *will not*, unless the cost of the latter is three times that of the former.

"Again, when an installation has to be worked by accumulators alone during a run of five or six hours, through the engine only being available during the day time, the form most, and I may add only, suitable, is the 'Sellon.' This battery also is the only one at present available for tramcars or boats by reason of its great storage capacity per pound of lead; it being at least double that of any other present form. But the life of these cells being very short unfits them for lighting purposes.

"Then, again, when batteries are required for use as regulators only, and not for storing—for instance, when gas engines are used or steam engines with varying loads, the 'Planté' form is the better of the two, as there is less fear of its getting out of order, though both forms are here applicable. For this purpose, also, I have found that cast lead plates, preferably with transverse ribs (to give them stability and at the same time to keep them as thin as possible), give extremely good results, and this at a very moderate cost indeed, far below that of any accumulator at the present time available, besides having at the same time all the qualities ot the best and most expensive. Of course its storage capacity for some time is practically *nil*, but this is not necessary, it only being used for steadying the lights, and for this surface and not capacity is required.

"From this I hope that I have made it sufficiently clear that there is no one form of accumulator that can be used for all the purposes for which they are required, and to put briefly the advantages of the two types, the 'Planté' form will *discharge* at a much higher rate, and is less liable to get out of order, whilst the 'Sellon' form is capable of receiving a much higher rate of *charge*, because it has a greater thickness of working material, and also stores a greater amount of electrical energy in a given weight. As regards the durability or life of either of these forms, it is impossible to give any definite data or results. Manufacturers *say* that their batteries will last a number of years, but this unfortunately has not as yet proved to be the case.

"Mr. Sellon takes to task Messrs. Elwell and Parker about the cost and weight of their battery over his, but it should be pointed out that he has taken the cost of their small circular cell (25s.), which is far more expensive in proportion to their one horse-power cell (having a useful storage capacity of 300 ampère hours) sold at 60s. If Mr. Sellon wished to make a comparison in prices, taking the 'Elwell-Parker' circular cell for a standard, he should, I think, have quoted the Electric Power Supply Company's small cell also, say the one sold at 16s., having a capacity of 35 ampère hours, thus bringing up the cost to £7 instead of £3. Lastly, as regards the weight of batteries, I think that for lighting purposes all electrical engineers will agree with me when I say that weight is *not* important, but durability and reliability are."

NOTES.

Conductors for Private Electric Lighting.—The question of allowing private electric lighting firms to run overhead wires or to open streets to lay conductors, was brought under the consideration of the Town Council of Glasgow at a recent meeting. Messrs. Muir and Mavor, of that city, had sought the permission of the public authorities to do both of those things, for the purpose of successfully carrying out a contract which they have entered into for continuing the electric light at the General Post Office in George Square. Instead of having their motive power generated on the premises, as has been the case during the past three years or so in the contract originally taken by Messrs. Crompton & Co., they propose to have a power station in Miller Street, a very short distance away from the Post Office, and to lead their conductors either underground or overhead, or both. Their application was first considered by the Statute Labour Committee, the result of whose deliberations was to recommend that Messrs. Muir and Mavor's application be not granted. Mr. Osborne desired to be informed of the exact grounds on which the committee had arrived at the decision recorded in their minutes. The contractors wished, he said, to take the wires underground, where they would be out of the way of everyone; and he thought that every member of the council would be agreed that underground were more desirable than overhead wires. Under the circumstances he desired that the matter should be sent back to the Statute Labour Committee for further consideration. The convener of the committee replied that the reason which had induced them to refuse the application was simply that the applicants were private contractors, and that it was known that if it were granted other contractors would ask for similar permission. It was eventually agreed that the matter should be taken back by the committee.

Electric Lighting for Erecting Shops.—Mr. F. D'A. Goold, electrical engineer, Manchester, has almost completed the lighting of Messrs. Sharp, Stewart and Co.'s works, the contract for which was placed in his hands about 10 days ago. The installation, when finished, will prove a great boon to the firm, especially in the erecting shops, where work could be but poorly performed by gas.

Mineral Oil Works Lighted by Electricity.—The Pumpherston Oil Company, Limited, near Uphall, N.B., having decided to light its premises, entrusted the work to Messrs. Henry Bennett & Co., Glasgow, who have fixed the necessary apparatus for five arc lamps. The dynamo is placed in the fan engine house, and is driven by the same engine as the fan, which has been fitted for the purpose with a sensitive governor. The lamps are hoisted on poles 45 to 50 feet high, and the total length of circuit is about 750 yards. One lamp lights the "tip" for the burnt shale, another the retorts, a third at the sulphate house lights the surrounding place, a fourth is placed so as to command the stills, and a fifth the space adjoining the refinery, including a range of steam boilers. The lights enable the out-door work to be carried on all night as well as in daylight, and the company expresses great satisfaction with the result.

Train Lighting by Electricity.—With reference to the letter to *Engineering* of Mr. W. H. Massey, given in our issue for December 27th, and the subsequent letters to which we referred in our leading article last week, the following correspondence has since taken place :—" A Traveller " says :—" It seems to me that the issue is not accumulators *v.* the spherical engine, and special dynamo of Mr. Crompton, because if experience decides that accumulators are desirable, it may still be found preferable to charge them by the Great Eastern system. The issue seems te be, driving a dynamo by a spherical engine *v.* driving by the van axle, and experience alone can finally decide." With regard to Mr. Massey's remark that Mr. Woodley *was* in favour of accumulators for train lighting, the latter gentleman writes :—" May I point out that at that time I knew of no engine sufficiently efficient and compact to mount on a locomotive to drive a dynamo. That problem was solved only when I became aware of Messrs. Heenan and Froude's spherical engine, which, with its 60-light dynamo, is contained in a box 3 feet by 13 inches, and weighs only 5 cwt., a very different thing to the apparatus used by Mr. Massey on the Metropolitan, which I venture to presume might look awkward mounted on a locomotive." Mr. Massey further writes :—" The arrangement of flexible platform cables described by Mr. Kapp in to-day's *Engineering* is one which has often been suggested to me by persons who imagine that carriage lights must be kept burning even when a locomotive is disconnected from its train at a *well-lighted* station ; but as this is really unnecessary, and as it would only complicate matters at junctions where trains are split up into several portions, the further consideration of this scheme may safely be deferred until the time when all our railway stations are permanently lighted by electricity, or until the 'travelling public at large' finds that it cannot get on without 'flexibles.' A locomotive engine is not a very little thing, and I fail to see the advantage of using 'a compact piece of mechanism,' which is dearer in the first instance, and which costs more to maintain it, than the 'rather bulky machinery ;' but Mr. Crompton writes as if it were more important to save space than to use fuel, and I fear that when our railway friends find out the false economy of this the electric lighting of railway carriages will be 'scotched' once more. Everything turns upon the question of expense, and I should not be surprised to find that the Great Eastern Railway Company is paying a high price for its light."

Amalgamating Interests.—In a letter received from Evansville, Ind., the writer says :—" We have an electric light company here, lately consolidated with the Gas Company, and furnishing both lights. I think this is something that cannot be found elsewhere."

The Electric Light in the New Stock Exchange Buildings.—On Tuesday afternoon the new extensions of the London Stock Exchange were for the first time illuminated by the electric light, and opened for the inspection of members and others interested. The new building, which is in the Italian style, consists mainly of a large octagonal hall, surmounted by a dome 70 feet in diameter, with transepts on two sides, one of which forms the connection with the old building. Underneath the main hall is a spacious settling room, and on the same floor there are two engine rooms, the further one being for the ventilating and heating machinery, and the nearer one for the electric light apparatus. The main hall is lighted by 76 Woodhouse and Rawson incandescent lamps, of 50 candle-power, mounted on wrought-iron brackets and standards, which are placed on the cornices of the building. The settling room below is lighted by 66 similar lamps of 20 candle-power, supported from the ceiling by wrought-iron pendants. The old Stock Exchange settling room and offices will be similarly illuminated. The machinery for generating the electric light consists of two Willan's high-speed compound engines, and two-feed boilers, each engine being readily capable of driving 650 incandescent lamps of 20 candle-power, and either boiler being capable of supplying the two engines. There are also three Elwell-Parker dynamos, arranged so that each engine drives a dynamo, and the third dynamo can be driven by either engine at pleasure. The trial of the electric lighting machinery is stated to have been quite satisfactory, the incandescent lamps giving a clear, steady light, without flickering. The whole of the electric lighting arrangements have been carried out by Messrs. Woodhouse and Rawson.

A Double Service.—The Connecticut District Telegraph and Electric Company sends both information and illumination over its wires. The company is running 79 arc lights in Waterbury, and has a district telegraph system at Meridien and Bridgeport, about 500 boxes being rented in the two last-named cities.

The Electric Lighting Act.—The *North British Daily Mail*, in an article upon this subject, says :—" Why not pass an Act providing that 21 years from the date on which it would come into operation, and every seven years thereafter, it should be in the power of any local authority to buy out the local gas company on reasonable terms ? That would put the electric light and gas in the same position, and do away with the evil of a perpetual monopoly. It would also ensure a healthy competition between the two lights, which would be for the benefit of the consumer."

The Telephone in France.—Experiments were conducted by means of the Van Rysselberghe system, on Monday, between Rouen and Havre, a distance of nearly 60 miles. M. Cochery and several distinguished deputies and academicians were present at Rouen, and conversed for nearly an hour with the Mayor of Havre and other notabilities of that town. The experiments were considered highly satisfactory, and M. Cochery announced on leaving that in a fortnight the public would be able to communicate telephonically between the two towns.

The Legal Effect of the Wallace Decision.—A circular has been issued by Mr. C. F. Livermore, President of the Molecular Telephone Company, giving the opinion of Messrs. W. H. Peckham, W. S. Knox, and A. Q. Keasbey on the decision by Judge Wallace in the Bell-Drawbaugh case. The opinion reads as follows :—In reply to yours of 4th inst. we would say that, in our opinion, the decision of Judge Wallace only affects the single defence set up by your company, among many others, of the inventions of Daniel Drawbaugh, which were set up by way of anticipation of Bell's patent. Indeed, Judge Wallace says that by the pleadings and arguments of counsel, practically the question for him to decide was whether Bell or Drawbaugh was the original inventor of the telephone and the principle involved in its operation. It seems to have been conceded in the case that either Bell or Drawbaugh was the original inventor of the telephone in the broad sense. Such a concession is, in our opinion, fatal to a fair trial or comprehensive decision of the merits of Bell's alleged invention and the validity of his patent. Your company rely, by way of anticipation, upon prior discoveries and inventions, which are proved, with a single exception, by publications and contemporaneous printed documents. There was no defence of non-infringement made in the Drawbaugh case, an important question in your case, neither does Bell's patent of 1876 seem to have been seriously attacked in what seems to us its manifestly vulnerable points, and Judge Wallace devotes but a trifling space to its consideration, and adopts the construction of the Circuit Court in Massachusetts in cases where there was the same want of vigourous attack, and where there was also the same fatal concession of Bell's title to the invention of the telephone. It seems also from the language of Judge Wallace's decision that it was also conceded that Bell or Drawbaugh was the discoverer of the undulatory current, and that it was the contention to which of them that discovery belonged. Nothing could be more unfounded than such a claim. The title of either or both of them is disproved by official documents that put that question beyond doubt. In conclusion, we see nothing in the decision referred to in your letter which has any effect, as a decision, upon any of the questions involved in the alleged discoveries and inventions of Daniel Drawbaugh.—*Electrical World.*

The Bell-Drawbaugh Case.—Judge Wallace has appointed John A. Shields, Master of the Court, to take and report an account of the gains, &c., which the People's Telephone Company has received since the 22nd day of June, 1880.

"Modern Views of Electricity."—Professor Oliver J. Lodge, F.R.S., of University College, Liverpool, this week and last delivered two lectures upon "Modern Views of Electricity," before crowded audiences at the London Institution.

The Fastnet Cable.—The steamer *Kangaroo*, belonging to the Telegraph Construction and Maintenance Company, sailed from the Royal Albert Dock, London, on Saturday, having on board the cable which is to connect Lloyd's signal station on the Fastnet with the postal telegraph office at Crookhaven, Co. Cork. The work of laying the cable will be carried out as quickly as the weather permits.

The *Kangaroo* was telegraphed from Crookhaven at a quarter-past five p.m. on Tuesday, as then entering the harbour.

The *Glasgow Herald*, speaking of the great value of telegraphic communication with lightships, says :—"It will enable the occupants to send instantaneous notice of any casualties that may happen in their vicinity, or indeed that they may hear of from passing vessels; and will thus prevent the loss of valuable time and valuable lives. It will also have a value of another kind, for it will put a stop to the false alarms which so frequently reach the lifeboat stations. During the course of last year the lifeboats on our coasts were launched no fewer than 142 times in reply to distress signals, but returned to shore, the crews having jeopardised their lives in vain, because the signals had either been made in error, or help was not required."

Edinburgh Royal Society.—At a meeting of the society on December 15th, Mr. Robert Gray in the chair, Mr. T. Andrews, F.C.S., gave a paper on "The Apparent Lines of Force on passing a Current through Water."

The New Method of Reckoning Time.—The Prime Meridian Metric and Decimal Committee of the Balloon Society has received a communication from Paris, stating that the French Government is now inclined to adopt Greenwich as the prime meridian, but defers giving a definite answer till after the Latin Monetary Conference in Paris, to be held on the 25th inst. The same committee is in communication with the Postmaster-General, the foreign telegraph companies, and scientific institutions, asking for their co-operation in adopting the new method of reckoning time.

Armington and Sims Engines.—An Armington and Sims engine of 100-H.P. has just been furnished the Russell Paper Co., to run a plant of Edison electric lights at the paper mill in Bellows Falls, Vt. This is the tenth engine of the A. and S. make purchased by William Russell & Co.

The Intercolonial Telegraphs.—The last consignment of telegraph wires for the extra intercolonial lines between Melbourne and Albury had come to hand, when the mail left, in excellent condition, and every effort was being made to push forward the construction of the new wires. It was expected that the work would be finished by November 20th. The extra line from Sydney to Albury has been available for some time.

Electrical Definitions.—At a recent meeting of the Société Internationale des Electriciens, M. Hospitalier read a paper on "Uniformity of Electrical Definitions, Conventions, Notations, and Symbols," at the end of which he moved the following resolution :—"We propose the nomination of a commission of electrical notation, charged with studying the question, and giving our proposition the sanction which seems best in the interest of electrical science." This was seconded by M. G. Cabanellas, and adopted unanimously.

Newspapers and Electrical Matters.—A writer in our namesake across the water makes the following remarks, which show that pretty much the same kind of thing obtains in America as in England :—"Inasmuch as every well-regulated paper thinks it of importance to employ an art editor, a literary editor, a dramatic and musical critic, and a financial editor, each, by a polite and pleasant fiction, supposed to be fully equipped to discuss and determine all questions which may arise in his special department, will the time ever come when it will be thought wise to confide electrical matters to some one who has at least a smattering of electrical knowledge—some one, for instance, who knows the difference between insulation and induction. How little the average 'art critic' has ever seen of real art, is a matter of common knowledge; how little familiarity the average 'literary editor' has with anything deserving the name of 'literature,' is proverbial; how uniformly the average 'financial editor' comes to grief when he goes into 'the street' and acts upon the advice which he daily deals out to his unfortunate readers, hundreds of seedy suits and shocking hats attest—but each and every one of these are bright and shining experts in their several departments compared with the gentlemen who 'prepare' the electrical 'copy' for the average daily newspaper in this country. A thing may antedate Faraday—it may go back to Volta and Galvani—if *they* have never seen it or heard of it before, it is *new* and *important*. Their antics would be ludicrous if they were not pitiful!"

The General Telephone Company of Paris.—A few months since the Société Général des Telephones of Paris, obtained a new working concession extending over a term of five years. This extension has given rise to a somewhat lively discussion in the Municipal Council of the Ville de Paris. The concession having been granted by the post and telegraph department without the intervention of the council, the question was recently brought before the municipal representatives, and several draft resolutions were submitted. A project has been suggested, according to which the telephonic réseau should belong to the city, the instruments being furnished by all the different makers of telephonic apparatus. M. Alphand, director of works, stated that he could give no encouragement to the laying of telephone wires in the sewers. These were already encumbered; in many of them water mains had yet to be laid, and it would become a material impossibility to place new lines in these underground passages. The question of overhead wires for Paris would thus appear likely to answer itself, and despite the objections, reasonable and otherwise, there is at least one practical illustration of the aerial system. At Vienna there exists a very extensive system of telephone wires, which are exclusively overhead; in some places no less than seventy-five wires are laid side by side, and, it is stated, that no complaints have ever been made.

The Western Union Telegraph Company, Limited.—An American Exchange says :—"The Western Union Company is said to have proposed a 10 per cent. reduction of pay as a Christmas present to its *employés*."

Dissolution of Partnership.—Messrs. Cordner, Allen & Co., of Bucklersbury, City, and Wandsworth Bridge Wharf, Fulham, electrical and general engineers, have dissolved partnership.

Electric Light Cables.—Continuing the controversy upon this subject commenced some weeks ago in a contemporary, and reproduced in our columns, Mr. J. G. Lorrain writes : Mr. Johnstone avoids the point at issue, which is, whether pure sand—I have all along discredited the use of chemically-charged sand, as sand with lime would be—could in the presence of water act upon lead. Mr. Johnstone's statements clearly meant that galvanic action could take place between the lead and the metallic bases of the colouring impurities of the quartz by the dissolving action of water. This is the statement which I characterised as absurd, because, before such metallic bases could act on the lead, they would have to be dissociated from the quartz. This dissociation could be brought about by treatment with hydrofluoric acid, or by fusion in the blowpipe flame with sodic carbonate, but certainly not by the action of water, as Mr. Johnstone states. To my mind Mr. Johnstone clearly shows by this statement that he has no practical knowledge of the subject. . . . . If the sand to be obtained at Greenock was not sufficiently pure, and individual peculiarities of the case favoured the employment of peat, the engineers were right in using the latter. The decision could not have been left to abler hands. Peat, as I have all along said, is by no means a bad material, though I consider sand to be preferable in most cases, because it does not retain water. Suggestions on the part of your readers of other materials which might be tried would be welcome, and some result of practical value might then arise from this correspondence."

Secondary Batteries.—There are, states the *Mechanical World*, "two Richards in the field," one represented by the Sellon Company and the other by the Elwell-Parker Company. First, Mr. Sellon professes to show that the Elwell-Parker battery is in reality the Sellon, but with some knowledge of the patent law any reader perusing his statement would conclude rightly that the evidence adduced would utterly fail to support his case in a court of law. After some further correspondence Mr. Reckenzaun, who is Mr. Sellon's electrician, produces the results of some tests which are so palpably absurd that we are surprised, not at the figures, but that an electrician of repute should have published them. Mr. Sellon follows this with more figures to the same effect, the general tendency of which is intended to show that the Sellon battery has six times the capacity and nearly twice the efficiency of the Elwell-Parker. Our own experience of the latter battery shows that there is something very radically wrong, and this is quite evident without that experience, for common sense would lead to the conclusion that if the Elwell-Parker battery was so deplorably defective it would not find employment as it does. We propose as soon as some tests in hand are complete to publish their results, but we have proceeded quite far enough with them to be convinced that however Mr. Sellon and his electrician arrived at their professed results with regard to their opponents' battery, they are hopelessly and irremediably inaccurate. This is greatly to be regretted, for we are distinctly of opinion that as such batteries go both are good.

The Hammond College.—We understand that the Hammond Company has arranged with Mr. H. E. Harrison, the principal, and Mr. C. J. Wilson, the chemical lecturer, of the Hammond Company Electrical Engineering College, to carry on their private practices as consulting electrical engineer and analytical and consulting chemist, respectively, at the company's college, 2, Red Lion Square, W.C.

The Telephone in Bavaria.—Besides Furth and Nuremburg, in Bavaria, the city of Augsburg is to be furnished with a telephonic system. The subscribers will be furnished with a microphone transmitter, with two Bell receivers and a magneto-electric call bell.

The Simplex Electric Light and Plant Company, Limited.—This company has fitted up a portion of Messrs. Ermen and Roby's mills at Patricroft, near Manchester, and the installation is giving great satisfaction. Owing to the speed the various machines were running at, the greatest difficulty was experienced to keep anything like a steady light with gas ; in fact, it was not uncommon for the gas jets to be blown out. The lamps employed were "Müller's" patent incandescent lamps, the patent for which is the property of the Simplex Company, which manufactures the lamps at the works, Valley Mill, Eccles. The dynamo is shunt wound, and is driven by a small horizontal engine. A temporary installation by means of a portable engine in connection with a bazaar during three nights recently at Eccles, and also a large marquee or ball room, lighted up by the same means, for a coming of age, were in both cases most successful. Amongst other works in hand is the lighting up of Messrs. J. Robertshaw and Sons mills, near Bradford ; Messrs. T. Ormerod & Co.'s mill, Haslingden. The company has also in hand work of considerable importance in connection with large mills, collieries, and other works, Mr. F. F. Bennett superintending the erection and work of installations.

New Electrical Business.—The Æolus Waterspray and General Ventilating Company, 235, High Holborn, has added an electrical department to its ventilating and heating business. This department will be under the management of Mr. Charles W. Stewart, certified electrician, late Royal Engineers.

The Electrical Power Storage Company.—During the past year this company has made several important developments in storage batteries. Profiting by the experience gained in installations and the laboratory, the design of the plates has been modified to meet the many requirements of practical working. Several important advances have been made in the use of the cells for the many purposes to which they are suited. Good work has been done in telegraphy, a number of lines having been in constant work in London, and the cells shown to keep their charge for over three months. The electric launches have been improved in details, and with the latest type of motive power cell can now be considered a commercial article. The tramcar, driven by accumulators and Reckenzaun's motors and gearing, has been running successfully for some months at the works, and will shortly be tried on a public line. Cells have been supplied for working electric hoists, for which they are admirably suited, as the hoist can be used at any time independently of the engine, and all transmission gearing is dispensed with. In electric lighting the use of the cells has extended considerably during the past year, and, among others, may be mentioned : Sir W. Armstrong, at private house ; Sir W. Armstrong & Co., for Italian Man-of-War ; Messrs. J. Edmundson & Co., Westminster, for private house lighting, &c. ; Messrs. J. H. Holmes and Co., Newcastle, for private house lighting, &c. ; Messrs. Siemens Brothers, the Society of Arts, C. J. Phipps, Esq., house lighting ; Messrs. Waterlow and Sons, supplying arc lamps for photography ; T. Nordenfelt, Esq., torpedo work ; Edison-Swan Co., house lighting, &c. ; A. Littleton, Esq., Sydenham, private house lighting ; Messrs. Strode & Co., house lighting ; H. J. Nicoll, Esq., arc and incandescent lighting ; W. Palmer, Esq., house lighting ; T. Flemons, Esq., H. Lafone, Esq., Electric Apparatus Co., lighting of carriages, &c. ; Edison Company, of Berlin, Van der Weyde Light Co., East and West India Dock Co., Messrs. Holmes and Vaudray, central station lighting ; J. P. Rayworth, Esq., Manchester ; the Cannstat Electric Co., &c. Cells have also been shipped to France, Germany, Holland, and Japan. It will be seen from the above that confidence in secondary batteries is rapidly spreading, and great progress may be expected in the coming year.

Trade Returns.—The official trade returns for December show that telegraphic wire to the value of £105,880 was exported during the month. Of caoutchouc, 198,000 cwt., of the value of £2,267, was imported during the year just passed, against 227,000 cwt., value £3,618, in 1883.

Engineering Inventions.—Sir Frederick Bramwell, F.R.S., the newly-elected President of the Civil Engineers, and who is also the Chairman of the Executive Council of the Inventions Exhibition, has chosen the subject of "Engineering Inventions," since 1862, as the subject of his inaugural address, to be delivered next Tuesday evening (13th January) at the society's house in Great George Street, Westminster.

NEW COMPANY REGISTERED.

Jablochkoff and General Electricity Company, Limited.—Capital £20,000, in £100 shares. Objects; To acquire the portion of the property and business of Jablochkoff Electric Light and Power Company, Limited (now in liquidation), comprised in an unregistered agreement of the 22nd ult. Signatories, with one share each: *W. G. Ainslie, East Sheen; *C. Samuel, 65 and 67, Ludgate Hill; *C. J. Taylor, 50, Courtfield Gardens, S.W.; *G. Metcalfe, 13, Copthall Court, E.C; E. Wadham, Dalton-in-Furness; Gaston Martineau, Esher; J. Toulmin Lawrence, North Finchley. Directing qualification: 5 shares. Registered 7th inst. by Messrs. Mills, Dowson & Co., 28, Bedford Row.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Davis and Timmins, Limited.—The statutory return of this company, made up the 15th of August, was filed on the 5th ult. The nominal capital is £10,000, in £10 shares. The number of shares taken up is as follows, viz.: 578 subscribed shares, upon which £1 per share has been called, and 200 fully paid vendors' shares. The calls paid amount to £578, and the sum of £5,157 has also been paid by shareholders in advance of calls.

Edison's Indian and Colonial Electric Company, Limited and Reduced.—The annual return of this company, made up to the 25th ult., was filed on the 1st inst. The nominal capital is £250,000, divided into 40,000 A and 10,000 B shares, of £5 each. The number of shares issued is 29,513 A shares, upon 24,513 of which, £2 10s. per share has been called up, and the full amount upon the remaining 5,000 shares. The calls paid amount to £86,072 10s., and unpaid to £210. As compared with the previous return, the paid up capital shows an increase of £4,210. Registered office, 3, Great Winchester Street, E.C.

Brush Midland Electric Light Company, Limited.—An extraordinary general meeting of the company was held at the offices, 4, Great Winchester Street, on the 24th ult., when Mr. Emile Garcke (the secretary of the Anglo-American Brush Electric Light Company, Limited) was appointed liquidator.

Standard Electric Light and Power Company, Limited.—The registered office of this company is at 31, Lombard Street.

Change of Office.—The registered office of Blanch Brain Brothers, Limited (mining and electric engineers), is now situate at Serridge, near Cinderford, Gloucestershire.

PROCEEDINGS OF SOCIETIES.

Dublin Royal Society.—November 17th.

(Section of Physical and Experimental Science).

Prof. J. EMERSON REYNOLDS, F.R.S., in the Chair.

"ON the analogy between heat and electricity," by Prof. G. F. FITSGERALD, F.R.S.—It was pointed out that the analogy, as usually drawn between heat and electricity, namely, to liken temperature to potential and quantity of heat to quantity of electricity, is not the true analogy, inasmuch as the product of temperature and quantity of heat is not of the nature of energy, and that the true analogue of quantity of electricity is quantity of entropy. In this case a non-conductor of electricity is a non-conductor of entropy, *i.e.*, a non-conductor of heat. As the quantity of electricity is the same at all parts of a circuit, and as it requires a perfect heat-engine to transfer entropy from one temperature to another undiminished, conductors must be of the nature of perfect heat-engines. It was further pointed out that a molecular structure of ether similar to that of a gas could be assumed, the motions of whose molecules might be polarised in such a way by differences of temperature that, although no heat was conducted, it would be thrown into a state of stress which would explain electrostatic phenomena. It was explained that this was a step beyond that made by Maxwell in his "Electricity and Magnetism," where he avoids any hypothesis as to how electric displacement produces mechanical stress. The author stated, however, that the object of this communication was not to bring forward this doubtful hypothesis, but, by drawing attention to this analogy between heat and electricity, to prevent the danger at present imminent of its being supposed that the analogy between electric displacements and the motions of an incompressible fluid is the only analogy possible, and of this mere analogy being consequently mistaken for a likeness.

Berlin Physical Society.—November 21st.

Prof. NEESEN reported on a case of magnetisation produced by a stroke of lightning, the distribution of which had been examined by a former pupil of the speaker. The lightning had struck the clock of a church tower, and so strongly magnetised it that it was only by great force that the pendulum could be moved from its position of rest, while the clock had to be taken to pieces and the magnetised iron parts demagnetised by means of heat. The most strongly-magnetic part was a U-shaped piece of cast iron, the two perpendicular and downward-directed legs of which bore the edges for the pendulum. The distribution of the magnetism in this piece of iron was as follows:—Not far from the lower ends (at about a third of the height) was a neutral point on both sides, the inferior piece on one side being north polar, on the other side south polar. On the side having the north pole, south polar magnetism was found above the neutral point, extending above the middle line and beyond, so as to take in about the upper third of the other leg. Thereupon followed an upper neutral point, between which and the lower neutral point of this side was found north polar magnetism. The two lower neutral points were the spots where the two legs of the U-shaped piece of iron were connected by a horizontal iron pin. Other effects of the lightning were not to be found either in the clock or on the church tower.

CITY NOTES, REPORTS, MEETINGS, &c.

Indian and Oriental Electrical Storage and Works Company, Limited.

AT the second ordinary general meeting of this company, held last week at the offices, 19, Great Winchester Street, E.C., Mr. Ernest Noel, M.P., presiding, the following report was submitted and adopted:—

"The directors submit the balance-sheet of the company from the formation thereof up to the 30th November, 1884, and add the following explanation as to its position at that date:—

"The whole of the first issue of 40,000 shares has been allotted, with the exception of 5,000, which are payable to the Electrical Power Storage Company, as portion of the consideration for the purchase of their patents; but which, owing to the non-completion of agreements between the companies, are still retained.

"The liabilities of the company were the paid-up capital and a sum of £1,978 11s. 3d. due as shown in the accounts. Of this sum £1,500 represents the directors' fees which have not been claimed.

"The accounts between the Electrical Power Storage Company, the Eastern Electric Light and Power Company, and this company, have been adjusted on the following basis, which the directors feel assured will be satisfactory to the shareholders:—The Electrical Power Storage Company waive their claim against this company for the balance of their account, as also for the expenses of electricians sent by them to Bombay, together with material. The Eastern Electric Light and Power Company waive their claim against this company for labour and material supplied by them in Bombay; and this company cancels the orders received from the Eastern Electric Light and Power Company, and has taken back all the batteries and materials in Bombay, and which are shown as stock there. By this adjustment this company has not been called upon to pay any further sums on account of the large disbursements made by the two companies before-mentioned in trying to make the batteries in India a permanent success.

"At the ordinary general meeting held on the 16th January last, the directors stated to the shareholders their intention not to undertake any engagements of the capital of the company without first consulting the shareholders. Your directors have now to report that they have not received any offers of business of such a character as would, in their opinion, be advantageous or of benefit to the company; and your directors have further to add that, looking most carefully to the interests of the shareholders, they have in every possible way reduced the expenses of the company. The sum of £3,000 on deposit as shown in the balance-sheet, your directors hope to keep intact; and the interest on this, together with the gradual collection of the outstanding calls, they trust, will be sufficient to meet the necessary outgoings of the company.

"They are happy to state, having made arrangements by which the company has been relieved of the salary of their Penang electrician, this gentleman has proceeded to that place under other engagements, and has been permitted to act there as this company's agent for the sale or otherwise of the company's plant, and from his intimate knowledge of same and erection thereof, he expresses great hopes of making a profitable realisation.

"In concluding the report, your directors are wishful that the shareholders should understand that their present policy is in conformity with the understanding come to at last January's meetings, to the effect that they would, to the utmost, reduce the expenses of the company; they have kept this in view and acted accordingly. They hope shortly to be able to propose an arrangement by which the further liability of the shareholders will be cancelled, and with that view they propose that the present convened meeting shall stand adjourned."

Mr. Ernest Noel, M.P., and Mr. W. M. Bullivant, retiring directors, were re-elected, as also were the auditors, Messrs. Deloitte, Dever, Griffiths & Co.

The Consolidated Telephone Construction and Maintenance Company, Limited.

At the offices, in Farringdon Street, an extraordinary meeting of the shareholders of this company was held, on Tuesday, to confirm a resolution reducing the capital.

The Chairman (Mr. C. L. W. Fitzgerald), after making some remarks of a hopeful kind with regard to the position and prospects of the company, moved:—"That the capital of the company, which is now £300,000, divided into 300,000 shares of £1 each, of which 224,850 are in issue and are fully paid, be reduced to £243,787 10s., divided into 224,850 shares of 15s. each, and 75,150 shares of £1 each, at present unissued; and that such reduction be effected by writing off from each of the said 224,850 shares the sum of 5s. per share as capital lost or unrepresented by available assets."

The resolution was agreed to, and the meeting terminated.

International Electric Company, Limited.—The balance-sheet made up to the 31st of October last shows that the general expenditure from the 31st of October, 1883, was £11,976, making a total expenditure to date of £32,411. The receipts amounted to £881, of which £444 had been received during the year. The report states that the board is not in a position to decide as yet what proportion of the past expenditure will have to be written off as loss, and what proportion should be kept in suspense, to be charged eventually to the particular business for the development of which it was incurred. No profit and loss account nor complete statement of the position of the company can, therefore, be submitted.

The Globe Telegraph and Trust Company, Limited.—This company announces the payment of an interim dividend, on and after the 19th inst., of 3s. per share on the preference shares, less income tax, and of 2s. per share on the ordinary shares, free of income tax, for the quarter ending January 18th, 1885.

The German Union Telegraph Company, Limited.—This company announces the payment of a dividend on the original preference shares of £15 each of 16s. 6d. for the financial year 1884, and of the interim dividend on the original shares of £15 each of 11s. 9d. per share.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of December was 3,001, estimated to produce £2,500, against 2,774 messages, producing £2,559 in the corresponding month of last year. The receipts for the month of September, estimated at £2,150, realised £2,163.

The Great Northern Telegraph Company. The receipts for December, 1884, £19,000; and from 1st January to 31st December, 1884, £276,280; for the corresponding months of 1883, £254,488; and for 1882, £241,373.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st December, are £2,278, as compared with £2,314 in the corresponding period of 1883.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of December, were £1,738, against £1,473 in the corresponding period of last year.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending December 31st were £3,790.

NEW PATENTS—1884.

16567. "Brushes for dynamo-electric machines." G. Hookham. Dated December 17.

16602. "Indicating apparatus for electric bells and other purposes." G. H. Jennings, S. Jennings, E. G. Brewer. Dated December 17.

16632. "Electric alarm watch or clock stand." J. Burmann. Dated December 18.

16639. "Incandescent electric apparatus, and apparatus and means used in the manufacture thereof or therein." J. S. Williams. Dated December 18.

16640. "Incandescent electric apparatus, and apparatus and means used in the manufacture thereof or therein." J. S. Williams. Dated December 18.

16641. "Incandescent electric apparatus, and apparatus and means used in the manufacture thereof." J. S. Williams. Dated December 18.

16642. "Incandescent electric lighting apparatus, and apparatus and means used in the manufacture thereof. J. S. Williams. Dated December 18.

16644. "Means and apparatus connected with establishing electrical communication between lightships and other floating bodies and the shore." F. Lake. Dated December 18.

16655. "Connections or couplings for electric leads, and for incandescent and other lamps." W. B. Sayers, G. Hookham. Dated December 19.

16656. "Electrical switches operated automatically and otherwise, and appliances to be used therewith." W. B. Sayers, G. Hookham. Dated December 19.

16728. "Electrical self-adjusting pendulum indicators." F. King, W. P. Mendham. Dated November 17. *(Complete.)*

16729. "Electric arc lamps." G. A. Nussbaum. Dated December 20.

16731. "Electrical switch for preventing sparking." J. A. Kingdon. Dated December 20.

16735. "Means for communicating by electricity between moving trains and fixed stations, or between moving trains." H. J. Allison. (Communicated by L. J. Phelps.) Dated December 20. *(Complete.)*

16764. "Continuous current dynamo-electric machines." S. Z. de Ferranti. Dated December 20.

16767. "Means for storing and transporting electrical energy." J. H. Johnson. Dated December 20.

16770. "Portable electric lamp." A. V. and G. V. Rose. Dated December 20.

16795. "Arc lamps." E. J. Paterson, J. Foxcroft. Dated December 22.

16799. "Telephones." Hon. W. J. Bethell. Dated December 22.

16805. "Production of a carbonisable material for making carbons for electric lamps, &c." F. Wynne, L. S. Powell. Dated December 22.

16825. "Telephone exchange call indicators." S. Williams. Dated December 23.

16840. "Telephone receivers." J. E. Fuller. Dated December 23. *(Complete.)*

16846. "Method of covering insulated electric wires with lead or other soft metal." A. D. Wilson. Dated December 23.

16890. "Electro gas engines." D. S. Regan. Dated December 24. *(Complete.)*

16910. "Distribution of electricity." S. Pitt. (Communicated by S. B. E. Turrettini.) Dated December 24.

16916. "Multipolar electric machines." J. D. F. Andrews. Dated December 24.

16920. "Galvanic batteries." J. Rapieff. Dated December 27.

16954. "Electro-telephonic apparatus." A. A. Campbell-Swinton. Dated December 27.

16964. "Telephonic switching apparatus." A. R. Bennett. Dated December 27.

16978. "Dynamo-electric machines." J. H. Greenhill. Dated November 11.

16983. "Electric arc vacuum lamp." G. W. Bayley. Dated December 29.

16997. "Driving dynamo-electric machinery." W. Mather. Dated December 29.

17008. "Electric arc lamps." J. G. Slatter. Dated December 29.

17011. "Ventilating and draining conduits for underground wires for telegraphic, telephonic, lighting, and other electrical purposes." J. B. Pash. (Communicated by T. R. James.) Dated December 29.

17017. "Electrically indicating the level of water in steam generators." B. H. Thwaite. Dated December 30.

17019. "Holding and supporting incandescent electric lamps." E. C. Walker. Dated December 30.

17028. "Application of magnetism to boots and shoes." J. Holbrook, C. D. Wiltshire. Dated December 30.

17034. "Galvanic batteries." G. Nifosi. Dated December 30.

17077. "Igniting gas by electricity." P. M. Justice. Communicated by C. W. Weiss.) Dated December 31.

17078. "Insulators for electrical conductors." P. M. Justice. (Communicated by H. L. James.) Dated December 31.

17090. "Producing rapid motion of rotation by means of hydraulic machines adapted especially to driving dynamo-electric machines." E. Ciotti. Dated December 31.

17091. "Magnetic-electric machines." H. F. Joel. Dated December 31.

17096. "Means or apparatus for manufacturing vacuum incandescent lamps and apparatus, or means employed therefor or therewith, partly applicable to other purposes." J. S. Williams. Dated December 31.

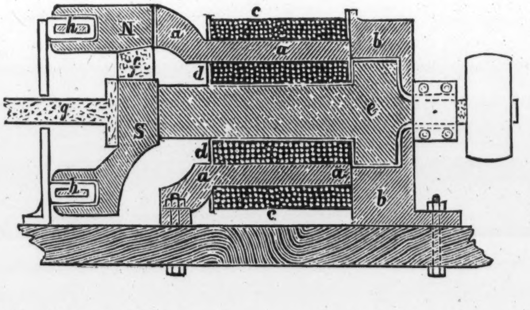
17099. "Means or apparatus for conducting, distributing, regulating, and transforming matter and force in a system of electric circuits and apparatus, or means employed therefor or therewith." J. S. Williams. Dated December 31.

17100. "Means or apparatus for conducting, distributing, regulating, and transforming matter and force in a system of electric circuits, and apparatus or means employed therefor or therewith." J. S. Williams. Dated December 31.

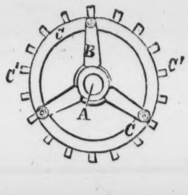
17107. "Electric-dynamo machines." W. H. Whitfeld. Dated December 31.

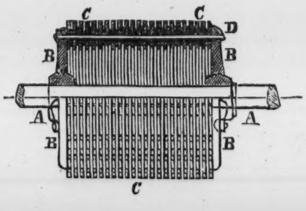
ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

231. "Improvements in dynamo-electric machines and electromotors." Sir Charles Bright. Dated January 1. 6d. The fig. shows a section in elevation of one mode of construction of the machine, in which an iron cylinder, *a*, *a*, *a*, *a*, fixed to an iron frame, *b*, *b*, and surrounded by a coil of insulated wire *c*, *c*, forms one of the poles of the field magnet. Concentric with this is an interior fixed coil, *d*, *d*, which polarises the other pole of the field magnet. This latter pole, s, is the end of an iron shaft, s, *e*, which rotates within coil, *d*, *d*, in close proximity to, but not in contact with it. A pole-piece, N, is fixed to the shaft, s, *e*, by a gun metal or other non-magnetic attachment, *f*. The shaft, s, *e*, is continued through its bearings by a non-magnetic extension, *g*. *h*, *h*, shows a section of the fixed armature coils attached to a circular bearing. The dotted spaces represent non-magnetic metal, such as gun metal or phosphor bronze.

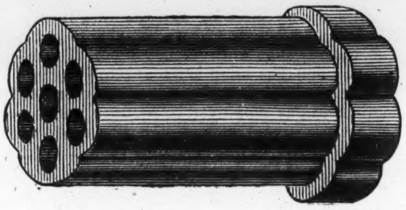


572. "Improvements in the armatures of dynamo machines." C. F. Cooper. Dated January 3. 6d. Fig. 1 is a side view partly in section, and fig. 2 is an end view of the armature of a dynamo-electric machine constructed in accordance with the invention. A is the axis of the armature. B, B are end frames of bronze or other non-magnetic metal. The frames have bosses by which they are keyed on to the axis, and radial arms connected at their outer ends by a ring. Between the two frames, B, B, a series of soft iron rings, C, C, are held, which rings may or may not have projections, C¹, C¹, to keep the windings of insulated wire in place, but the use of such projections is not considered novel. D, D, are bolts passing through all the rings, C, C, by holes made to receive them and also through holes in the end of the frames. The bolts are rivetted at their ends and they secure the soft iron rings to the end frames, B, B, and so to the axis, A. The rings, C, C, have no radial arms or interior projections for keeping the wire in place, and are unconnected with the axis except by the end frames, B, B. The absence of arms and bosses to the rings allows of better distribution and arrangement of the coils and allows of a freer circulation of air.

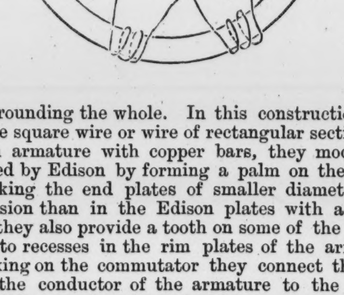




748. "Protecting underground electric wires." H. H. Slade and W. A. Slade. Dated January 5. 4d. A pipe or tile divided into two or more channels so that one or more covered electric wires might be placed in each, the object being to separate the cable containing all the wires of a system so that one portion might be renewed, altered, repaired, increased or removed without disturbing the whole lot. Glazed stoneware pipes or tiles are recommended in the first place as they will prevent latent defects in the insulating material developing themselves as quickly as they do in iron pipes, but other material might afterwards be found better adapted to the purpose or less expensive. The drawings shows one of the pipes and tiles, but they may be made of all sizes and shapes and with any number of holes.



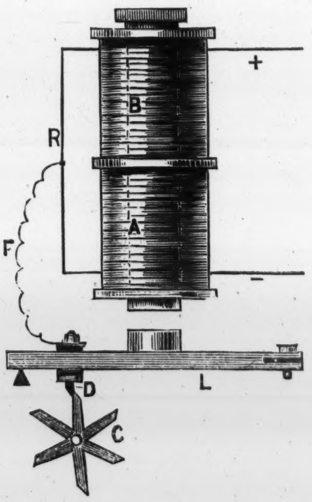
768. "Improvements in dynamo-electric machines." J. Hopkinson and W. Mather. Dated January 5. 6d. The invention is more particularly applicable to the type of machine known as the Siemens-Alteneck and modifications thereof, but is in part capable of being used with other dynamo machines. In order to remove the heat generated in the armature wires, the inventors make use of a fan which may be fixed to the driving pulley or to the shaft of the machine. They also provide fixed covers for the armature, and in some cases an extension of a portion of the fan to surround a portion of the armature so that the fan may either drive or draw a current of air over the surface of the armature. These covers also serve as a mechanical protection against injury. The collecting brushes, instead of being formed in wide bundles of wire, as in the Edison machines, have each bundle divided into fascicles, each of which may be removed separately, being held by a separate screw, without stopping the machine. In order to put a greater quantity of copper into a given space, the inventors wind the armature with a number of strands of naked wire and insulate the whole group of wires when the armature is wound by a covering of fabric surrounding the whole. In this construction it is preferable to use square wire or wire of rectangular section. In constructing an armature with copper bars, they modify the construction used by Edison by forming a palm on the ends of the bars and making the end plates of smaller diameter, having a longer extension than in the Edison plates with a shoulder on either side, they also provide a tooth on some of the copper bars to engage into recesses in the rim plates of the armature. To reduce sparking on the commutator they connect the successive sections of the conductor of the armature to the commutator plates by a ribbon or wire of metal of less section than the conductor itself. For machines of low electromotive force they modify the method of winding and connecting the armature and commutator usual in the machines of Gramme and Siemens, thus:—Suppose there to be *m*, *n*, sections in the armature and bars in the commutator, call the bars (1) (2) (3) and so on to (*m*, *n*) the sections of the armature are successively connected to plates (1) and $(m + 1)$, $(m + 1)$ and $(2m + 1)$, and so on till $(n - 1)$ $(m + 1)$ and (1) again (2) and $(m + 2)$, and so on, so that instead of having *m*, *n*, sections connected seriatim, as in the usual method, they have *m* so connected and *n* parallel. The brushes



on either side must never touch less than n plates at once. The fig. shows the application of the method by a case where $m = 2$ and $n = 4$. The short straight lines illustrate the bars or plates of the two circles; the armature ring and the coils represent the wires connected up to the commutator bars or plates in the manner before described.

806. "Improvements in electric safety lamps." T. COAD. Dated January 5. 6d. Relates to improvements in miners' incandescent electric safety lamps, the object of the invention being chiefly to provide means whereby on the breakage of the caseing or lantern of the lamp sparking will be prevented when the electric current is broken and the lamp extinguished. The improvements consist principally in preventing such sparking by constructing the contact pieces of sufficient length, and in placing over such contact pieces a covering of suitable material, such as India rubber or the like, which will closely embrace the parts so as to effectually exclude all dangerous gas from coming into contact with the sparks produced on the breaking of the electric current. And further, in order to prevent the sparking which might be produced by metallic contact, whether accidental or otherwise, the inventor dispenses with the use of terminals by carrying the conducting lines direct from the lamp into the battery, so that when the lamp is fixed thereto, the wires will be entirely enclosed and protected. In order to prevent the escape of the carbonic acid gas employed to produce the pressure within the glass casing, the inventor employs a flanged disc and a flanged ring. The outer glass casing consists of a flanged dome, the bottom of the flange of the dome resting against the upper face of the disc, and the top of the flange bearing against the underside of the flanged ring. The said disc and ring are clamped together by bolts and nuts so as to allow of securing by means of suitable packing a tight joint between the glass and the ring and disc, thereby effectually preventing the escape of the compressed gas.

898. "Improvements in arc lamps." JAMES BROCKIE. Dated January 7. 6d. The inventor uses a star wheel, C, as the last or regulating wheel in an arc lamp train, and its teeth are engaged by a detent, D, controlled by the shunt magnet, A, the detent, D, is insulated from the lever, L, in contact with the positive parts of the lamp. This regulating shunt magnet is wound with two coils, A and B, in series, but in opposite directions, so that although a current may exist in the circuit, the magnet will be practically non-magnetised. A flexible or other convenient conductor, F, is attached to the shunt circuit, where the winding begins in the reverse direction, as at R; and the other end of this flexible or other conductor is connected to the insulated detent, D, which engages the star wheel, C. Now it will be seen that as long as any of the metal arms of the star wheel make contact with the detent as shown, one of the coils, B, of the shunt magnet will be cut out or short circuited; the path of the current being from the positive star wheel and detent, D, through the coil, A, the free end of which is in contact with the negative of lamp. Now this coil is the regulating coil, and magnetises the regulating magnet; when the arc gets too long, this magnet of course becomes more powerful, and will in due time lift the detent, D, clear of the metal star wheel, this latter then revolves and the carbons will approach, but as the second or reversing coil, B, is instantly put in circuit, the magnet becomes practically powerless, and the detent, D, drops into the teeth of the star wheel, permitting in practice only one tooth to escape at a time. This up-and-down movement and consequent partial rotation of the star wheel will continue until the carbons have approached sufficiently to reduce the arc to its normal resistance. It will be seen that by this method of arranging the shunt circuit, and putting the duty of contact making and breaking upon the star wheel, the sparking at the contacts is much reduced, and as each limb of the star wheel is a contact, the reduced sparking is again distributed amongst many contacts, so that they will remain in good condition for a considerable time; the oxidation of important contacts in make and brake lamps being a serious objection to their use. The resistance of the reversing coil, B, may be very small in comparison with that of the regulating coil A, as it is not necessary to reverse the polarity of the magnet absolutely; it is only necessary to weaken it sufficiently to allow the lever, L (carrying the detent D) to fall away from the pole of the magnet when the coil is put in. The regulating coil, A, may be wound with iron or German silver wire, and the reversing coil, B, with copper wire, in which case the resistance of the reversing coil, B, may be very small in proportion to the other, A, and the sparking due to the change of potential be thus reduced if required.



927. "Improvements in electro gilding." J. RECORD. Dated January 8. 2d. This invention consists in the employment of a new solution to be used for this purpose. The inventor takes salts of nickel five ounces, dissolved in about two gallons of water with twelve ounces of cyanide of potassium, so that the nickel salts may be taken up quite clear. He then boils the solution until the ammonia contained in the nickel salts is entirely evaporated. This solution is then added to the ordinary gold solution containing one ounce of gold, the result being a considerable saving in gold.

1612. "Improved mode of and mechanism for forming underground conduits." J. H. JOHNSON. (Communicated from abroad by C. Detrick, E. W. Bond, both of America.) Dated January 17. 6d. Consists in forming an underground conduit in a trench by the continuous packing of cement, or other equivalent material, round a former within a tube which retreats as the continuous packing proceeds, the conduit thus formed remaining in the trench.

11715. "Improvements in and relating to electrical signalling and apparatus therefor, chiefly designed for use in connection with telephonic systems." W. R. LAKE. (Communicated from abroad by the Equitable Electric Company of America.) Dated August 27. 6d. Relates to improvements in electrical communication and to apparatus therefor, whereby a person calling up a distant station or subscriber is automatically notified whether any one is there present to receive his message, or to put him into communication with another station or subscriber, or is notified of the time when the said called station will be attended or ready to receive messages, if the attendant be absent; thus saving considerable time to the operator making the call, as he will refrain from continually making the call, as he now does, if he is not immediately responded to, and will wait until the time indicated before he again calls up said station or subscriber. To accomplish this desirable result the inventor arranges in close proximity to the call apparatus or bell, an automatic responding instrument, operated by means of a spring or other motor, and locked or prevented from acting by the armature or other moving part of the call apparatus or bell, when the same is inoperative or in its normal position. The call apparatus and responding instrument may be contained in one case. The automatic responding instrument is constructed to pass to line currents induced from the action of an independent battery in certain predetermined impulses, upon the call apparatus or bell being actuated from the calling station; which actuation of this call apparatus or bell releases the responding instrument, which is immediately operated by the motor, and so sends the predetermined signal to the calling station.

CORRESPONDENCE.

Secondary Batteries.

In your last issue you publish a letter from Messrs. Elwell-Parker & Co., referring to correspondence, of which extracts only have appeared in your journal, the publication *in extenso* having taken place in *Engineering* from the 28th November up to present date. It is not possible for your readers to estimate with accuracy and justice all the points or bearings of this correspondence without having seen the whole of it, or to form their opinion of the tone of my portion of it from that of Messrs. Elwell-Parker's last communication. For the information of those who have not the opportunity of looking through *Engineering*, I will give a very brief *resumè* of what has passed. In the report which appeared in that journal upon the Healtheries Exhibition, reference was made to Messrs. Elwell-Parker's exhibit as being a new and improved *form of accumulator* patented by that firm and by Mr. Planté. I would here state that in your journal of the 16th September, 1882, I had already called attention to the fact that I had anticipated Mr. Planté's patent as to any such form of accumulator, by nearly a year, writing to you as follows:—

September 11th, 1882. . . . . "Without in any way desiring to detract from the discoveries of that most eminent man to whom the first honour is due, and should be ungrudgingly rendered by all who have worked upon his original ideas, it is nevertheless right for me to state that the principle of roughening the lead plates was very fully worked out by me last year (1881), and is described by my patent specification, September 10th, 1881. The roughening by nitric acid being one of the most natural chemical processes is obviously therein referred to." . . . .

In *Engineering* of the 28th November last (in consequence of the report on the "Healtheries" alluded to) I gave extracts side by side from the patent, August 4th, 1882, of Messrs. Elwell-Parker & Co., and from mine, September 10th, 1881, so that readers might draw their own conclusions, but I did not enter into any discussion as to patent law, or into any comparison of the merits of various types of batteries. This was followed in the next week's issue by a letter from an anonymous correspondent "Electrolyte," who questioned my right to patent broadly the process of roughening plates, and asked pointedly if prior to Messrs. Elwell-Parker I had ever manufactured a battery equal to theirs? Following this was a letter from Messrs. Elwell-Parker, making claims on behalf of M. Planté's batteries as being as yet "unsurpassed." The next stage is a letter from Mr. Reckenzaun, who gives his experience of the Elwell-Parker cells as compared with the Faure-Sellon (which figures appear in your journal of 26th ult.), and a somewhat long letter from myself, extracts from which you also give. This is followed by Messrs. Elwell-Parker's letter which appears in extenso in your issue of 2nd inst., and which I feel, in the absence of what I had written to *Engineering* (which it is intended to answer), gives an entirely erroneous idea of the point at issue and of the general tone of my correspondence. As an instance of this they quote the efficiency of the Electrical Power Storage cells used by Mr. Anderson for his experiments nearly a year ago (which I had fully explained were of an old form), as 63 per cent. only, but they omit to state the fact that *their* cells tested under the same conditions, and with the same care, and of much more recent construction than the Storage Company's cells, only gave 42 per cent. Again, I in no way called in question, nor would I do so, the "care, integrity, or reliability" of M. Planté or Mr. Parker, but by inference those who read Mr. Elwell's letter might think I had done so. Altogether a tone is thus given to the correspondence which is undesirable and is unjust towards myself.

I will now briefly touch upon one or two points in answer to Messrs. Elwell, Parker and Co.:—

1. As to the present *improved construction* which they claim for their cells.

It has come (but only quite recently) to my knowledge that they have altered their type of cell from that upon which Mr. Anderson's experiments were made, and which is, however, of the same type, I believe, as those which they exhibited exclusively at the "Healtheries." But what is the alteration? It is simply a close imitation in form, arrangement, and connections of my cells, and I quite agree with them that it is a decided improvement. Unfortunately, however, for themselves and their customers, they have not got over the difficulty of infringing my patents in using "perforated roughened and indented" sheets of lead.

2. As to the *rate of charge and discharge.*

It is not only contrary to fact but to common sense, to suppose that their form, in which no packing of active material is used, can be either charged or discharged as rapidly as my packed plates; the difference in my favour in both cases is so very great that the point is not worth argument.

3. As to *efficiency.*—Well and carefully worked cells of my form yield an average efficiency in ordinary work *far above* 70 per cent. The Elwell-Parker or any other cells *should*, of course, give practically the same result if once properly and fully formed, and if worked under equal conditions and at rates *corresponding to their size, shape and capabilities*, the chief relative difference rests naturally on these points.

4. As to *capacity* per pound of lead.—Mr. Elwell need not have limited himself to the modest figures of 5 ampère hours per pound as being *possible* with his plates; he might, in the absence of any data as to their thickness or durability, have claimed three or four times that amount. This correspondence should deal only with a recognised commercial and substantially made article, not with a laboratory plaything.

5. *As to relative durability.*—This can only be arrived at by the experience of years. Batteries of my form under proper treatment have been in constant and successful work very much longer than any of the present manufacture of Elwell-Parker cells have (so far as I know) existed. This point is therefore not one which can be summarily disposed of.

6. As to the gratuitous assumption of Mr. Elwell that his plates when experimented upon by Mr. Anderson had been kept dry and exposed to air for a long time before being used. I have made enquiries and have found that this was not the case; but I may remark that with my form of plates, if properly made and stored away, their being kept in such a condition for months and even years before using, would not materially affect them.

With regard to Mr. Geere Howard's suggestion in last week's *Engineering* that the Elwell-Parker cells are well adapted for "regulators," I have no wish to dispute the point, but he may not be aware that for this purpose the Electrical Power Storage Company have now a special construction in hand far cheaper and less bulky than those he refers to, and which it seems probable will supersede every other existing form, including Messrs. Elwell-Parker's, even assuming for the moment that those gentlemen possess the right (which I contend they have not, and of which they have long since received notice) of supplying their present forms of batteries to the public during the existence of my patents.

John S. Sellon.

The Hall, Sydenham,
January 7th, 1885.

Copy of letter sent to "Engineering."

At the request of Messrs. Elwell and Parker I venture once more to intrude upon your valuable space and reply to those portions of their letter which refer to me in particular.

In the first place, when one obtains a new secondary battery from the makers it may be assumed that the same is in a fit state for immediate use; at all events the plates should be "formed" and ready for coupling up with the corresponding poles of the charging apparatus. The set of Elwell-Parker accumulators, containing "formed" plates, of the type referred to in my former letter, was charged at the rate of 10 ampères for 15 hours, and then discharged at an average rate of 12 ampères until the current dropped 10 per cent. (which I call the *useful rate*), giving a return of 33 ampère hours, but the *total* discharge, allowing the current to drop to 2 ampères was 37 ampère hours; for commercial purposes, however, it is not desirable to work the cells until completely exhausted; in fact in most cases a drop of 10 per cent. in the current rate is all that can be allowed. Observing that the *capacity* of the cells appeared to be much below 150 ampère hours, they were next charged to 130 ampère hours, and the experiments repeated, every time reducing the amount of charge, whilst keeping the *rate* the same, until the charge came to 50 ampère hours; the average *useful* capacity, however, never reached above 33 ampère hours, and a return of 30 out of 60, after repeated trials, was considered the best for that type of cell. It may be mentioned that these tests were made in consecutive order, day after day, never allowing the plates to get dry, nor to stand idle for more than the hours of the night; the acid employed was of 1,170 gravity, the temperature averaged 60 degrees Fahrenheit, and the external resistance was practically constant.

Seeing a number of cells of similar shape and construction at the recent Health Exhibition I inferred that those experimented upon by me have not been superseded, but as Messrs. Elwell and Parker mention in their letter of the 31st ult. that vast improvements have been made more recently, it would be of great interest if these gentlemen were to publish at once the best results obtainable in practice with their accumulators, stating weights, current rates, efficiency, useful capacity, and dimensions. The subject is of immense importance, and I, for one, should be glad to hear that the weight of lead batteries could be materially decreased or the capacity materially increased beyond the figures which I have published in your esteemed journal when referring to the accumulators made by the Electrical Power Storage Company.

I omitted to point out that the cells used in the electrical tram car, containing 26·5 lbs. of lead each, give a current *rate* of 100 ampères for a considerable time, and that the starting of the heavy car up a steep incline requires 170 ampères, which these cells readily give at frequent intervals, whilst the motor is arranged to work safely with such currents, although the average rate necessary is only 46 ampères, the cells being always in series.

Messrs. Elwell and Parker say that I did not order the cells from them, and that I did not advise them as to the carrying out of tests for my information.

The cells were ordered and purchased by a friend of mine, who is not connected with the Electrical Power Storage Company, and if Messrs. Elwell and Parker will refer to their letter file of *seven* months ago they will find that I *did* advise them ; in fact I wrote to say that I desired to obtain particulars of all the best secondary batteries in the market; but they sent me an answer declining to give me any information whatsoever, whilst other firms responded to my request most cordially, and the Electrical Power Storage Company not only made special cells for me but they went subsequently to the expense of constructing a tram car to my designs in order to demonstrate the practical utility of their wares.

A. Reckenzaun.

London, *January 5th*, 1885.

Having had some experience of the secondary batteries made by the E. P. S. Co., and also those of Elwell-Parker, I beg to quote from a record kept by a client to whom I have supplied a set of 25 circular Elwell-Parker cells, which have been in regular work since about June last :—

	Charge. Ampère hours.		Discharge. Lamp hours. H.	M.
October	22—40 A.H.	... ...	9	15
„	23— 5 A.H.	... ...	16	0
„	24 ...	... ...	6	35
„	25—40 A.H.	... ...	6	35
„	26 ...	... ...	9	25
„	27 ...	... ...	6	30
„	28—12 A.H.	... ...	12	0
„	29 ...	... ...	3	0
„	30 ...	... ...	9	0
„	31—24 A.H.	... ...	6	15
November	1 ...	... ...	11	30
„	2 ...	... ...	5	30
Ampère hours	121	Lamp hours	101	35

The lamps are 48 V. Swan 16 C.P., except three, which are Woodhouse and Rawson, 45 V. 20 C.P.

I regret that I cannot give the output exactly in ampère hours ; I can only say that the lamps average over 1 ampère apiece, and are so bright that a single one is sufficient for a room 24 feet by 18 feet, and that they give rather more light than a good duplex paraffin lamp. Of the E. P. S. cells I can only say that I have seen them doing good work in skilled hands, but that they cannot compare with the Elwell-Parker batteries for ease of management and durability, as far as my limited experience goes.

F. M. Newton.

Barton Grange, Taunton,
January 6th, 1885.

Heating by Electricity.

In Mr. Sellon's letter with reference to electrical heating, contained in your issue of January 3rd, the experiments made in France for heating railway carriages electrically, as well as the practical experiments described by Mr. Sellon, are interesting and important ; but it seems necessary to draw Mr. Sellon's attention to the fact that his patent, No. 4961, of 1883, is not the first of his own bearing on such subject, there being a prior patent of his relating thereto, viz., No. 924, of April, 1883. Nor is the patent mentioned by him of Mr. Oswald Rose, of May, 1882, the first attempt to "deal practically with the subject."

In a patent, No. 5233, of 1881, and also in one, No. 2558, of 1882, provision was made for carrying into practical operation electrical heating, realising the conditions foreshadowed in the letter of Mr. Sellon.

In my patent of 1881, provision was made for regulating or proportioning the consumption of energy automatically, in accordance with thermic or atmospheric conditions, and for varying the automatic regulation.

Electric foot-warmers were also shown and described operating under such conditions, together with electric heaters constructed so as to provide for the heating and circulation of liquids or air, the operations of which were also made controllable.

Mr. Sellon specially suggests an arrangement in connection with electric heating apparatus for using "salts, such as acetate of soda," for "the heating of carriages," so that such "can be carried out with still greater facility and convenience, and at a very low cost." The use of acetate of soda, or equivalent substances, in connection with electric heaters were also described and claimed by me in 1881.

In fact, the various appliances for carrying the subject matter of Mr. Sellon's letter into effective operation were fully set forth and broadly claimed as early as 1881. It is, however, due from me to state that Mr. Lane-Fox obtained a patent in 1878, in which he proposed applying electricity for heating purposes.

Please insert the foregoing, and oblige

J. S. Williams.

January 6th, 1885.

The Bell Telephone Patent.

The question that has been recently discussed in your columns as to the meaning of the words "equivalent plate" in Bell's patent appears to be really a very simple one, though doubtless every attempt will be made by those who are interested in Bell's patent to make it appear very complicated. The meaning of the word "equivalent" is contained in the word itself ; it must be equal in all material respects ; thus, if a piece of machinery has three functions to perform, can another piece of machinery which will perform two of those functions only, be an equivalent for the piece which has to perform, and does perform, the three functions ? Common sense answers "No." The iron or steel plate armature in Bell's telephone has these three duties to perform : First, it has to act as an ordinary armature to the magnet ; Second, it has to act as a spring ; Third, it has to act as a sounding-board or sound magnifier ; and it does all these three. Consequently it would appear that a plate of wood, or of any metal which is not capable of magnetic induction, can not be "an equivalent plate" for the iron or steel plate of the ordinary Bell telephone. But if the owners of the Bell patent start the doctrine of an "equivalent plate," they will find themselves in this difficulty, that is, that it will be at once replied to them that the iron plate of the present form of telephone is nothing more or less than the precise equivalent acoustic, electrical, and mechanical, of the diaphragm of goldbeater's skin with the small plate of iron attached, which was used in the telephone known as "The English Mechanic Receiver," which has been disclaimed, and has been declared open to the public.

I have previously pointed out in these columns that the Court of Appeal has, in my view, limited the Bell patent to a particular combination of parts; if I am right in this view, and I think that any who will carefully study those judgments will adopt the same view, then any telephone which is not the same combination of parts is not an infringement of Bell's patent, as such patent is now limited by such judgment. Any defendant in a patent action has the clear right of making the plaintiff disclaim everything in the patent that is not new; so that any workman of ordinary intelligence who may be employed to make an article, may be able to know, with the patent before him, whether he is, or is not, infringing the patent. The new patent law contains special provisions on this point; and although these provisions were probably inserted for the benefit of the patentee, and not for the benefit of the public, they operate equally against, or in favour of, both sides.

Again, Bell has always been placed before the Courts as a meritorious inventor; and the Courts have in consequence placed a "benevolent construction" on his patent; Bell's claim to be a meritorious inventor has been based on his alleged discovery of the undulatory current as described by him in his patent. In some letters that I addressed to the ELECTRICAL REVIEW, in the spring of 1882, but which I was prevented by a broken right arm from continuing, I endeavoured to give some of the reasons which had led me to form the opinion that an undulatory current as described by Bell was not required for the reproduction of articulate speech and, indeed, that such a current was not capable of reproducing speech; but that a make-and-break current, or current of sudden impulses, would reproduce speech; and that the action of the telephone as a receiver, with a hard carbon microphone as a transmitter, could not be explained on the theory of Bell's undulatory current; and could only be explained on the theory of a make-and-break current or current of sudden impulses. This view is, I find, gaining ground amongst those who are not interested in upholding Bell's patent; indeed, one person, of large experience in telephone matters, said to me: "Oh, that undulatory current is all humbug!" It should be remembered, too, that this undulatory current had been previously, and there is strong reason to believe with Bell's knowledge, written of, spoken of, and actually claimed to be used, by Reis.

The owners of Bell's patent are constantly threatening actions for infringement—a process sometimes called in America "Bragging a patent;" but I entertain no doubt but that if a tolerably strong company was formed to introduce and work a good telephone, which was not that combination of parts of which the Bell telephone receiver consists, they could maintain their right to use it.

H. B. T. Strangways.

5, Pump Court, Temple, E.C.,
January 5th, 1885.

Arc Lamps for Shop Lighting.

It may interest your readers to know that I have had working for several weeks, and giving great satisfaction (by illuminating the Woodhouse Lane shop windows), an arc electric light. It displaces 18 gas lights, each consuming 4 feet per hour, and gives about three times the light.

The lamp is worked by an A Gramme dynamo, driven by the Otto gas engine at our works, about 100 yards distant, the current of 18 ampères at 45 volts being conveyed by an overhead silicium bronze wire. The actual cost, including gas, carbons, oil, &c., is 2½d. per hour, which is only slightly in excess of the cost of gas previously consumed.

It is a noteworthy fact that this is the first arc installation used for shop lighting in Leeds.

Thomas Briggs.

25, Woodhouse Lane, Leeds,
January 5th, 1885.

Train Lighting by Electricity.

As the question of train lighting must be interesting both to those interested in electric lighting, and also to the general public, I beg to offer the following remarks.

It appears to me that the van accumulator arrangement, though very beautiful at first sight, is wrong in principle; and however well it may be made to work in a special installation such as that under trial, it will, I feel sure, be left far behind by other methods when put to the test of continuous practical work.

It is quite a different matter, as every engineer knows, to achieve success in a special case where the installation is watched over by the heads of the departments, and to succeed under ordinary conditions, subject to the rough usage, blunders, accidents, &c., of railway life.

I should like first to point out that the supposed economy of the system is really no economy at all; since the work done by the axle acts merely as an extra load in the van, or, in other words, an extra drag upon the engine.

We have in this plan the boiler furnishing steam to turn the engine. The engine pulls its train along, and with it the van, causing the axles to revolve.

By means of a strap from the axle the power is communicated to the dynamo, presumably by means of a countershaft.

The work done by the axle in driving the dynamo tends to stop it revolving, very much as a brake does, with the result that the engine (the locomotive) must exert an extra pull to overcome this, requiring extra steam from the boiler.

Now take the case of the high-speed engine, taking its steam direct from the boilers, and communicating its motion directly to the dynamo.

We have here exactly the same action at first hand, as with the axle at second or third hand.

What will be the difference in efficiency of the two systems? In other words, what power will be uselessly expended in each?

The power expended in the lamps and dynamo may be taken as a fixed quantity in each case, unaffected by the method of delivering the power to the dynamo. We lose then in the van experiment the power expended in turning the countershaft between the axle and the dynamo; and we lose by the increased friction of the axle itself.

With the high-speed engine seated on the locomotive we lose the power expended in driving the engine itself, overcoming the friction of its bearings, moving its weights, &c., before it begins to do work outside.

I think it will be found that there is not a great difference between these two.

When two rival systems are equal, or nearly so, in point of economy, it is usual to look at other features in order to determine which system is the best for certain work.

In the case of new, untried apparatus, several points immediately strike us as important. For instance: simplicity and durability, convenience, attention required. How do these two systems compare in these respects? I think that in point of simplicity the separate engine must carry the palm far before the van accumulator method, particularly when it is remembered that, though there are numerous mechanics about a railway, there will be few men having sufficient knowledge of the latest forms of electrical apparatus to properly look after the complicated arrangement of secondary batteries, automatic switches, &c.

Next, as to durability. The question here is, as to the relative life of the parts of high-speed engines; and of the plates of secondary batteries, the countershaft, the regulating devices; and last, but not least, of the axle itself. High-speed engines undoubtedly do wear faster than slow-speed engines; but, on the other hand, the wearing parts are light, inexpensive, and should be easily replaced.

On the other hand, we have no reliable data as to the actual life—the average life—of secondary battery plates; and I think we may fairly put the question to railway engineers, is it wise in bringing an additional strain of 4 or 5 H.P. or more, as it might easily be with a long, well-lighted train, upon *a single axle* of a van?

Then as to convenience. Provided that both plans work equally well, the van method would be superior, inasmuch as the lights would not be out when the engine was detached. But may not the van occasionally be detached? and could not some plan similar to that suggested by Mr. Kapp be adopted when the engine was detached? Unfortunately, if a general service is contemplated, terminal stations on branch lines, usually very small ones, and often not well lighted, must be taken into consideration. Here, again, the question arises, would it be a great inconvenience at those stations if the train lights were out for a short time? Are they not, even now, and at large stations? But I think the answer to all the objections is, to have a small secondary battery in the van that would come into action whenever the engine was detached and continue the lighting, and that could be made by suitable arrangements, to furnish *some* light for several hours in case of a breakdown.

It appears to me that a combination of the two methods in the existing state of the question would get over all the immediate difficulties.

I think, however, that for the ultimate success of train lighting by electricity, every carriage will have to be made absolutely independent of its neighbour, so that no matter where it goes it carries its light with it.

It appears to me that this can easily be arranged by placing a *small* dynamo and a small accumulator in each carriage. The joint power of the two must, of course, be well equal to the work they would be required to do.

The dynamo would be geared permanently to the axle, and connected to the lights and the secondary battery in the usual way. An arrangement would be provided, say in a lock-up cupboard, or other convenient place, so that the lights could be turned out at will, or a resistance thrown in to economise the storage power of the accumulator in case of a breakdown.

As by this plan a very small additional strain would be brought to bear on each axle, and, moreover, it would not be difficult to arrange the speed of the dynamo, the power of the lights and worm or bevel gearing, with few intermediate parts between the axle of the carriage and the axle of the armature of the dynamo, I think a great many of the practical difficulties that now beset the adoption of the electric light for railway trains would be overcome.

Sydney F. Walker.

Cardiff, *January 5th*, 1885.

The Bell and Edison Telephone Patents.

Your correspondent "F. T. H." evidently has not understood my remarks as to the "high standing" of your correspondents, else he would not have expressed himself towards me in the discourteous terms in his letter in the REVIEW of January 3rd.

I am yet to know that the initials "F. T. H." or any other initials have any "standing" at all that would give weight to his statements. If the writer's identity were well known, then his adopted signature would have the same weight as he would be entitled to.

In regard to "F. T. H.'s" opinion upon the validity of the Bell patent in reference to the substitution of the words "*equivalent plate*" for the word "*material*," my statement was that the patent would be void if a Court should sustain the claim put forward by the learned counsel, Mr. Moulton, that a wooden plate with iron bar armature is within the patent in virtue of the "alteration."

Bell's patent may be valid so far as the iron plate as described by "F. T. H."; but I respectfully submit that in my opinion it is not a valid patent because of a prior publication of one of the claims, namely, the first claim in the patent as disclaimed, which claim is "*ipsissimis verbis*" the same as the second claim in Bell's United States patent of February, 1876, published with drawings of his membrane and iron tongue instrument, in the *Gazette* of the U. S. Patent Office, March 6th, 1876, on file in the British Patent Office on the 3rd July, 1876. In support of my opinion that the patent is void, I quote a judgment delivered by that eminent jurist Lord Ellenborough: "An inventor's claim to novelty is destroyed by showing previous publication of the invention in some printed work in use in Great Britain, or in the specifications of a former patent. If prior to his obtaining a patent, any part of that which is of the substance of the invention has been communicated to the public in the shape of a specification of any other patent, he cannot claim the benefit of his invention." And I cite also a judgment of the House of Lords, delivered by Lord Chancellor Lyndhurst: "If the machine is published in a book distinctly and clearly described, corresponding with the description in the specification of the patent, though it has never been worked, is not that an answer to the patent?" and Lord Brougham added: "It negatives being the true inventor."

In the REVIEW of February 18th, 1882, will be found a letter reciting the claims of the two patents; and in the REVIEW of March 18th, same year, will be found a letter citing the above referred to judgments. The patent can be amended by disclaimer, by application to the Patent Office for leave to amend. I seriously object to your correspondent saying that I put forward Mr. Moulton's opinion as being of any weight upon this subject. Had he turned to the REVIEW of 23rd December, 1882, referred to by me, he would have found my frank opinion of the weight I attach to the opinions in this matter of Mr. Moulton. He will there find the opinion of this very learned barrister "That the Gower-Bell telephone transmitter is not an infringement of Edison's patent of 1877, as amended by proposed disclaimer." This opinion, however, was given on 21st March, 1881, for a fee paid to him by the Gower-Bell party—of course, before he became one of the numerous counsel of the U. T. Co.; but when on 9th December, 1882, he gave an opinion that the Gent transmitter, which has no diaphragm, was an infringement, he received his fee from the U. T. Co., "*tempora mutantur et non mutamur cum illis.*" I agree fully with "F.T.H." as to the quantum of weight to which the opinions on this subject of that distinguished electrician and counsellor may be entitled. In fact, I believe if some wag should advertise a telephone receiver made of the extreme end of a sunbeam, and a telephone transmitter made of green cheese, this eminent electrician would discover that to be an infringement of his client's patents.

The U. T. Co. will, I hope, soon have occasion to require the services of their counsellor-electrician to prove to the Court that a novel form of Hughes microphone, without the semblance of a diaphragm or tympan—even allowing the very broad *legal* construction put upon the words "diaphragm" and "tympan" by Mr. Justice Fry—is an infringement of Edison's patent.

Your correspondent "F. T. H." says of such a microphone, "if it is made of wood and carbon, whatever may be its outward construction, it is a resonant case and tension regulator."

Now I take leave to inform your correspondent that I have just such a microphone as described above, without a resonant case, or the semblance of one. It is made under Boult's specification, No. 11,363, 1884 (not yet published), and it is not in a box or case when in actual use. There is no substance other than air above or below the microphone, and yet the distinguished counsellor of the U. T. Co. has given his opinion that it is an infringement of Edison's patent.

The fact seems to be that the word telephone transmitter conjures before the affrighted souls of the U. T. Co., and of its numerous well-paid supporters, a diaphragm whose existence is but the creation of their diseased brain, a diaphragm as real and as susceptible of touch as was the dagger of Macbeth susceptible of being "clutched."

W. C. Barney.

January, 5th, 1884.

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